9th Annual International Cost Schedule Performance Management Conference

October 19-23, 1997, Tysons Corner, Virginia

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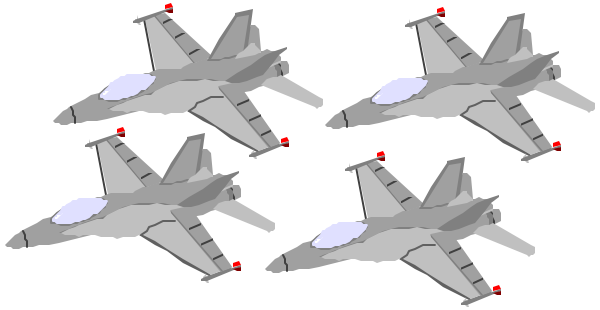
Earned Value Management

Future Directions in DoD

Wayne Abba
Office of the Under Secretary of Defense
(Acquisition & Technology)

Earned Value Management

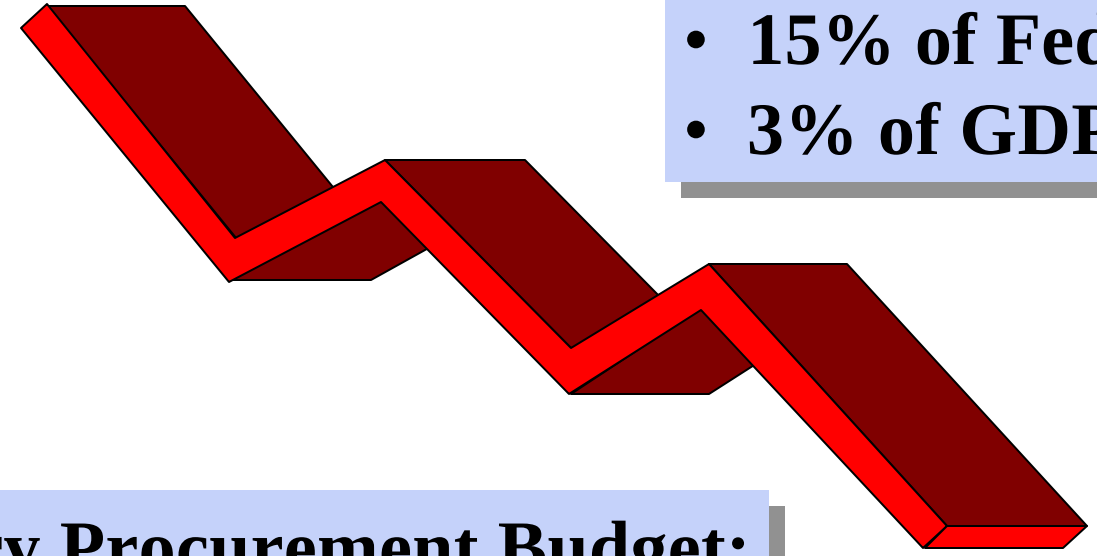
- The facts of (DoD procurement) life
- EVM beginnings
  - DoD contracting requirement
- EVM status
  - Government/Industry best practice
- EVM future
  - DoD’s role



1961 Pentagon Spending:
- **40% of Federal Budget**
- **8% of GDP**

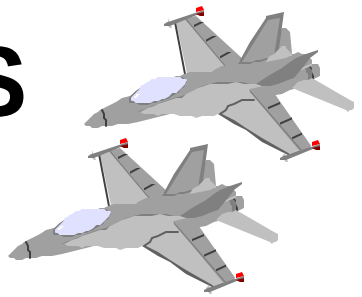
1997 Pentagon Spending:
- **15% of Federal Budget**
- **3% of GDP**

$$$



Military Procurement Budget:
- **Down 67% since 1985 peak**

$



DoD Responses

- Acquisition Reform
- "The Last Supper"
  - 1993 SecDef dinner
  - Fewer, larger companies
- Improved Defense Project Management
  - Better integrate cost, schedule, technical perf.
  - Earned Value Management

“And then there were 3”

Lockheed
GD Mil. Jets
Sanders Assoc.
} Lockheed

Martin Marietta
GD Rockets
GE Aerospace
} Martin Marietta

Loral
Unisys Defense
IBM Fed. Systems
LTV Missiles
Ford Aerospace
Goodyear Aerospace
} Loral

} Lockheed Martin

Northrop
LTV Aircraft
Grumman
Westinghouse Def
} Northrop Grumman

Boeing
Rockwell Def & Space
McDonnell Douglas
} Boeing

} Boeing

Raytheon
E-Systems
} Raytheon

Texas Instruments Def
} Texas Instruments Def

Hughes Aircraft
Magnavox Def
CAE Link
GD Missiles
} Hughes Aircraft

} Raytheon

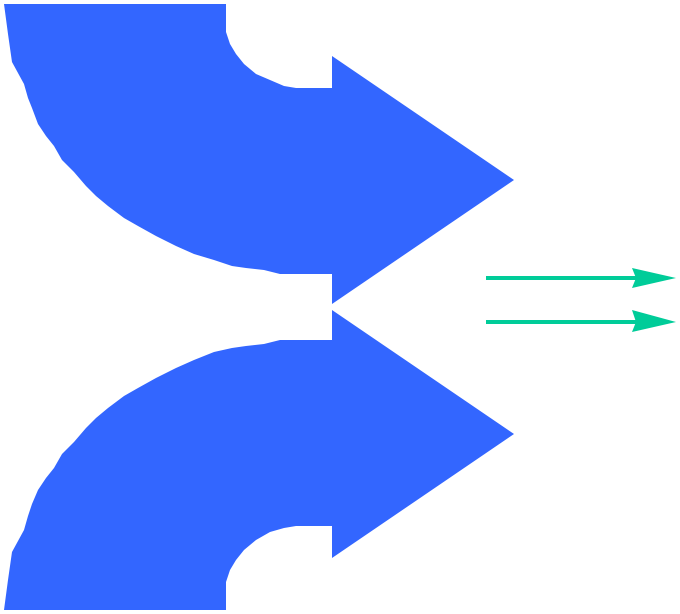
Industrial Base Concerns

- **Market forces**
  - **Monopsony**
  - **Monopoly**
  - **Price gouging**
- **Vertical integration**
- **Innovation**
- **Quality**

"The late 1990s and the early 21st Century will mark a difficult and expensive procurement era."

Earned Value Management: Origins

Industry Best Practices



Government Requirements

1967: DoD Instruction 7000.2
35 Cost/Schedule Control Systems Criteria (C/SCSC)

Criterion-based Management

- Brief statements of attributes
- Not “how-to manage”
- Not a system
- Minimum acceptable standard

1997: DoD Regulation 5000.2-R
32 Earned Value Management Systems (EVMS) Criteria

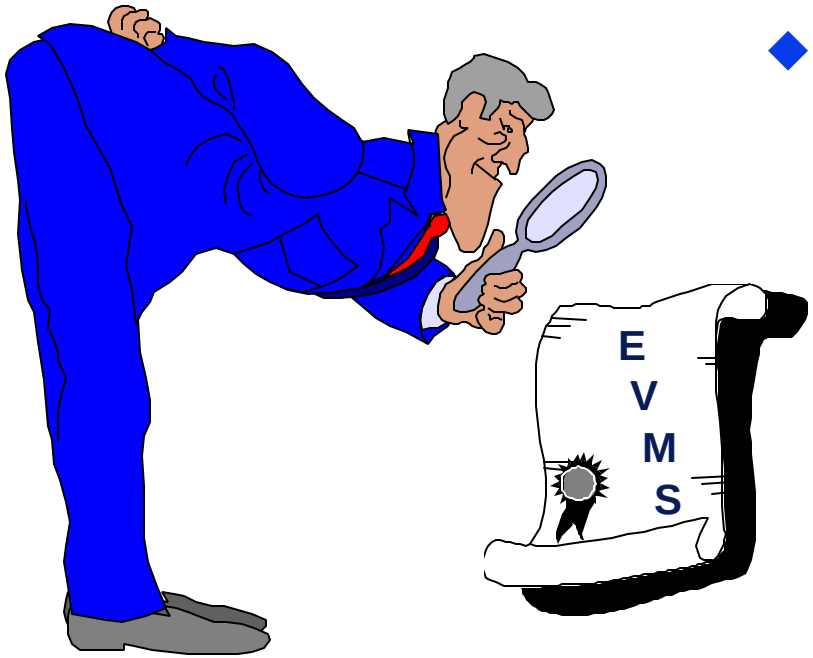
Earned Value Management: Implementation Problems

- **"Financial Management"**
- **Audit-like reviews**
- **Government-required reporting**
- **Too many "surprises"**
  - **A-12 (Navy)**
  - **AAWS-M (Army)**
  - **C-17 (Air Force)**
- **Challenge: keep good principles, stop bad practices**

Earned Value Management: DoD Improvements

- **Redefined Earned Value Ownership**
  - **From finance to project management**
  - **From reporting to management**
  - **From government to industry**
- **Better management tools**
- **Integrated Baseline Reviews**
  - **Planning process**
  - **Better technical/risk management**

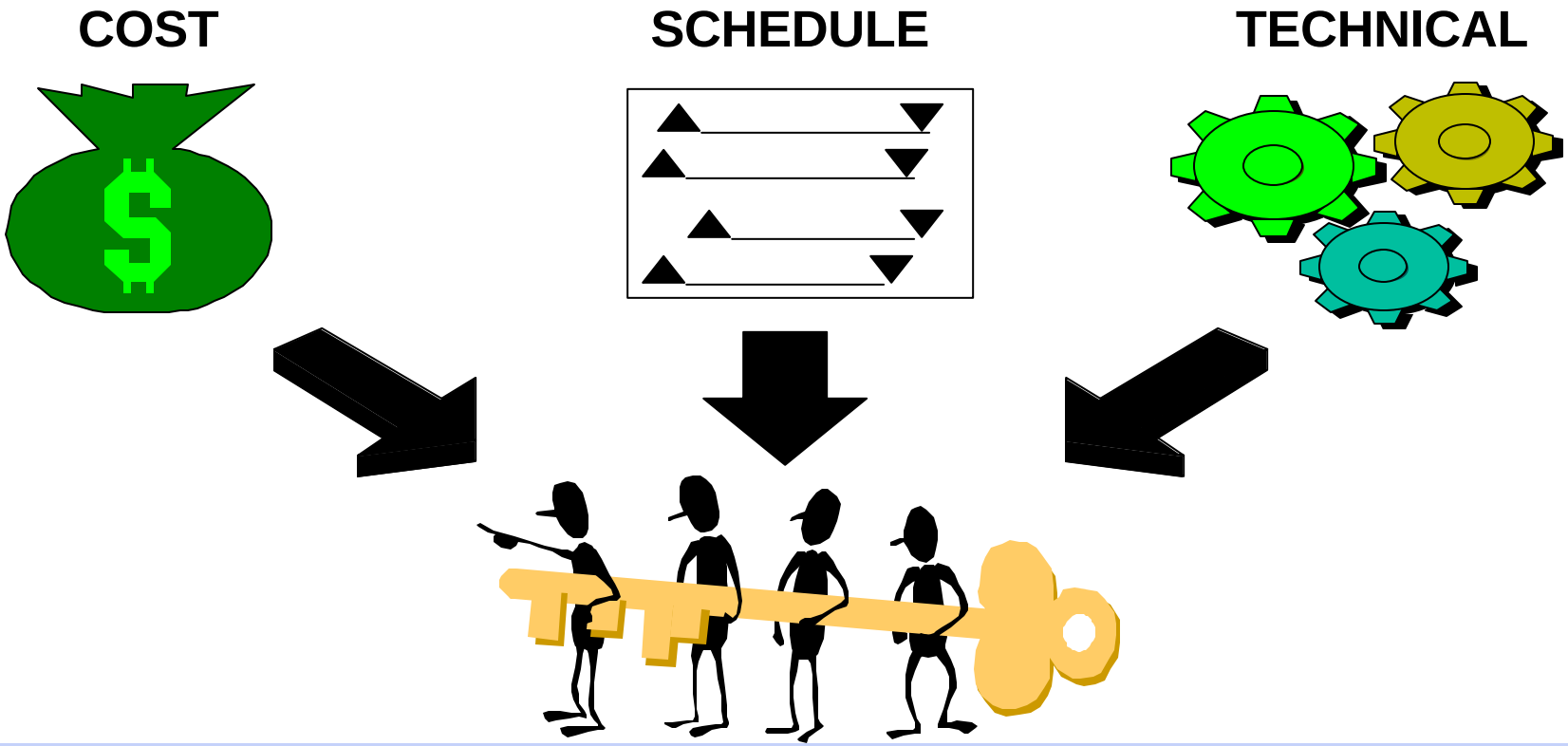
DoD Earned Value Policy



- **Examined & Reaffirmed**
  - **1984 - Arthur D. Little Study**
  - **1991 - DoD Instruction 5000.2**
  - **1993 - Inspector General Report**
  - **1994 - Coopers & Lybrand Study**
  - **1996 - DoD Regulation 5000.2-R**
  - **1996 - Office of Management & Budget Circular A-11 Part 3**
  - **1997 - General Accounting Office Report**

Australia, Canada, New Zealand, Sweden, United Kingdom

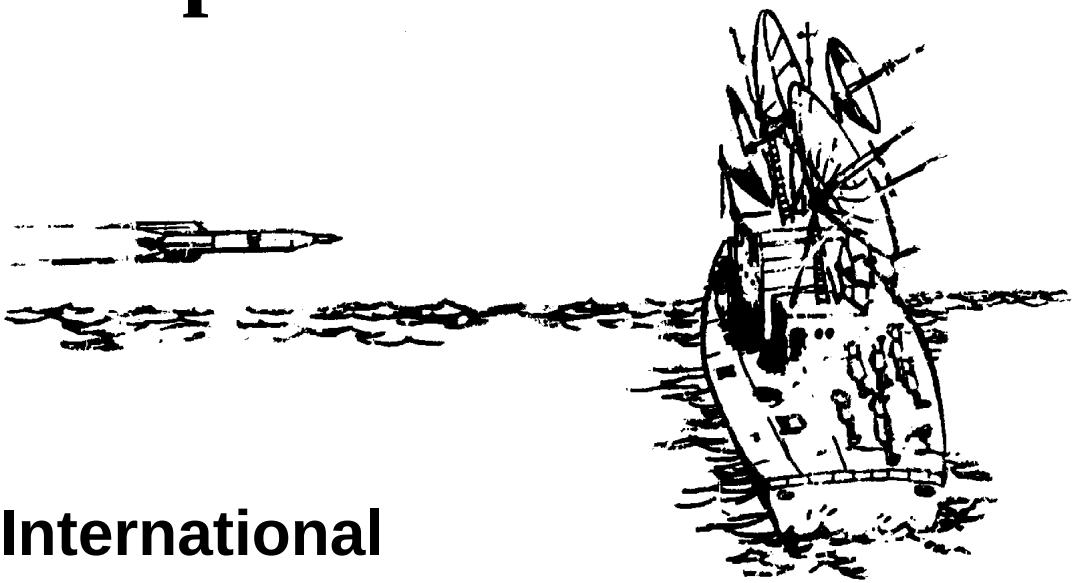
Integrated Product Teams: The Key to Success



Management systems don't manage - people do!
EVM is used to identify, communicate and MANAGE the resource effect of technical and schedule problems

The Really Nice Thing About Not Planning

Failure comes as a complete surprise and is not preceded by long periods of worry and depression!*



*Micro Planning International

Integrated Baseline Reviews

- **Mutual understanding of plan for**
  - **Scope**
  - **Schedule**
  - **Resources**
- **Emphasis on risk**
- **Planning process vs. review**
- **PM leads; EVM staff supports**
  - **Management system reviews effectively eliminated**

Putting it all together: IPT + IBR + EVM = IPM

- Involve earned value specialists and cost estimators on program IPTs
- Tailor reports - limit levels and analysis
- Do Integrated Baseline Reviews
- Encourage active, forward-looking management

"IPTs must control all the project, technical and functional elements needed for the product or process."

Earned Value Management: Gov't/Industry Best Practice

- Dec. 1996 USD(A&T) accepted 32 EVMS guidelines as replacement for C/SCSC
- Reserved right for government reviews
  - As determined by project manager
  - "Self-certification" not in public interest
- Encourages evolution to "true" standard
  - Industry/International (ISO)
  - For now, DoD and industry EVMS are equal

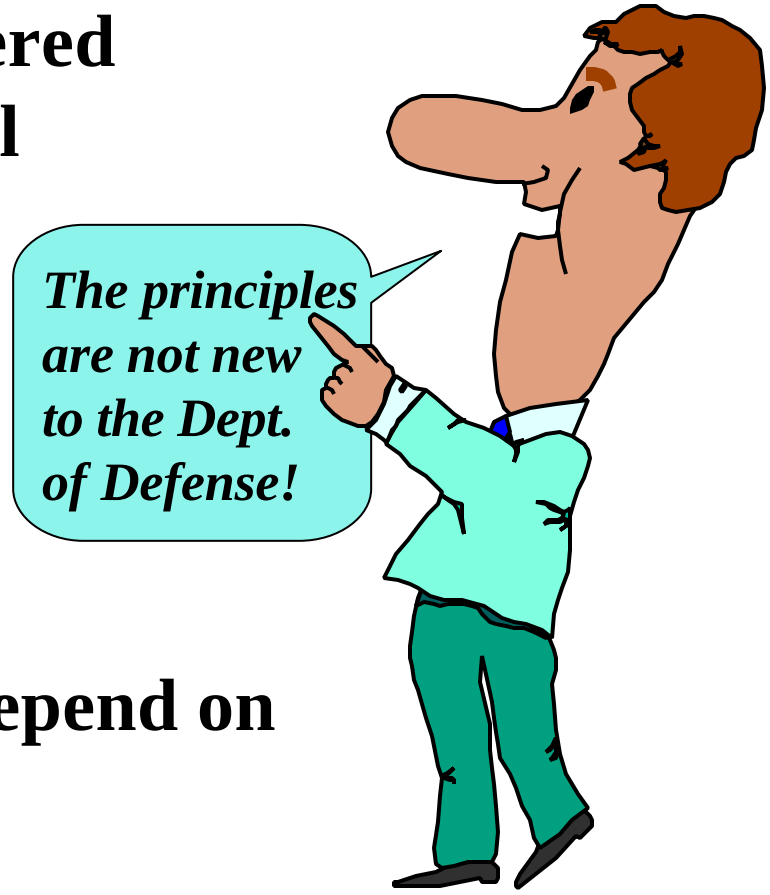
Earned Value Management: The Future

- **Office of Management & Budget Guidance**
  - **1996 - Circular A-11 Part 3**
  - **1997 - Principles of Budgeting for Capital Asset Acquisitions (FY98 Budget)**
  - **1997 - Capital Programming Guide (Supplement to A-11 Part 3)**
- **Government-wide management principles**

American Project Management Forum

Earned Value Management: The Future

- **A-11 Part 3 extends DoD-pioneered performance measurement to all agencies**
- **It effectively requires Earned Value Management for all contractor performance-based management systems**
- **Agency budget approvals will depend on *performance* measured by EVM**



EVM: A 30-year old idea is today's best practice!

Earned Value Management: The DoD's Role

- Integrated Program Management Initiative
- Monitor industry standards
- Participate in standards-setting bodies
- Continue inter-agency cooperation
- Improve project management education
  - Within government
  - Cooperate with academia and professions
- Improve in-house management

THE WORK BREAKDOWN STRUCTURE IN AN ACQUISITION REFORM ENVIRONMENT

Prepared For:

COST SCHEDULE PERFORMANCE MANAGEMENT CONFERENCE

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OVERVIEW

- Background
- Acquisition Reform
- Work Breakdown Structure Definition
- Work Breakdown Structure Development Process
- Uses of Work Breakdown Structure
- Contract Business Management Overview
- GAO Review
- Issues in Work Breakdown Structure Development
- Relationship with Contractor Management System
- Summary

BACKGROUND

- MIL-STD-881 Developed to Standardized Materiel Defense Items Definitions for Planning, Coordinating and Controlling the Technical and Cost Aspects of a Program
- Reflect Importance of:
  - Technology
  - Software
  - Contractor Organization/Practices
- With Acquisition Reform, MIL-STDs no longer applicable
  - MIL-STD-881 remained essentially in effect (Kaminski Letter)
  - Implementation was still required for Program Managers
  - Contractors utilize to ensure complete and accurate reporting
- MIL-HDBK on Work Breakdown Structures replacing MIL-STD
  - Focus on Government vs. Contractor implementation
  - Follows Acquisition Process

ACQUISITION REFORM

- Implementation of Acquisition Reform includes:
  - Streamline Acquisition (Commercial Practices)
  - Use of Integrated Product Teams
  - EVMS vs. C/SCSC (Insight vs. Oversight)
  - Cost as An Independent Variable (CAIV)
  - Reduction of Government Oversight
    - SOO vs. SOW
    - Elimination of MIL-STDs and MIL-SPECs
    - Addition of Integrated Management Plans and Schedules
- The WBS Remains the Definitive Framework for Government and Industry Communication for Technical, Cost and Schedule Elements

WORK BREAKDOWN STRUCTURE DEFINITION

DEFINITION

- A Product Oriented Family Tree of Hardware, Software Services and Data Which Results from Systems Engineering Efforts During Development and Production of a System
- Displays and Defines the Product(s) and Relates the Elements of Work to Each Other and the End Product, and Completely Defines the Program
- Plays a Key Role in Developing/Tracking Costs; Provides a Framework for Financial Reporting
- A Work Breakdown Structure (WBS):
  - Does Not Drive a Program's Requirements
  - Helps Identify the Interfaces Between the Government and Contractor, and Between Contractors
  - Provides the Framework for Integrating the Program Acquisition Requirements

WORK BREAKDOWN STRUCTURE DEFINITIONS (CONT'D)

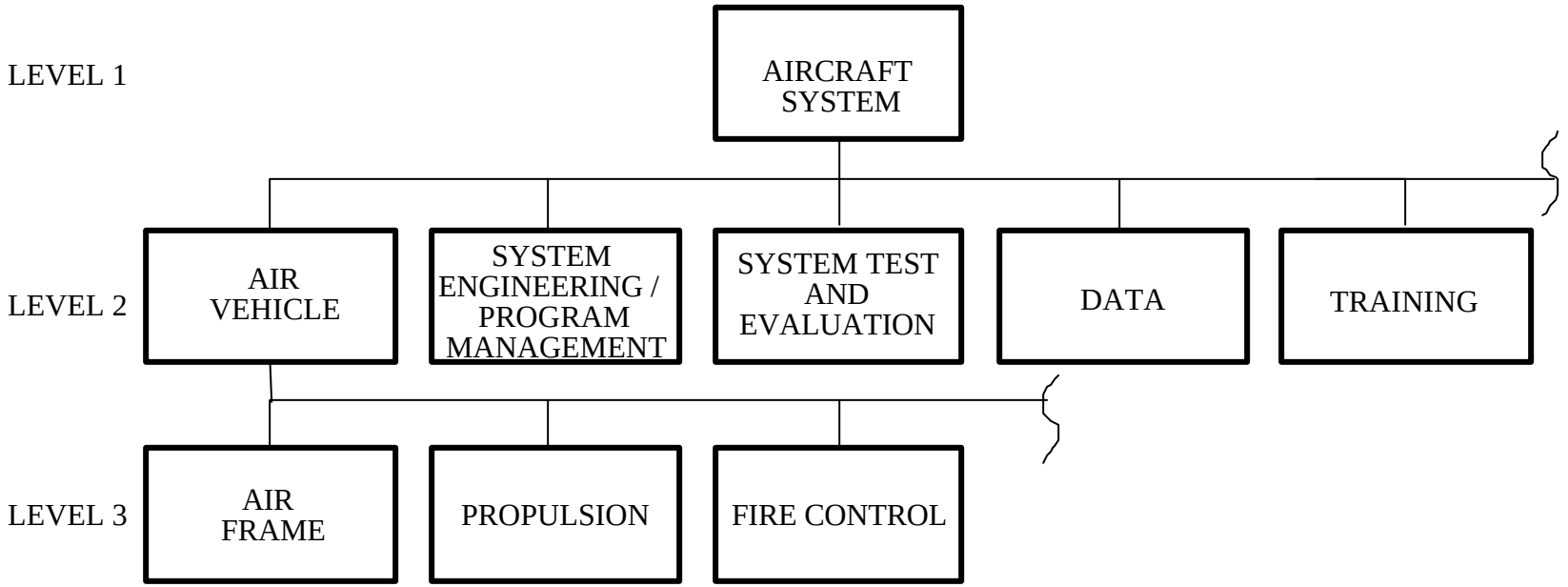
Two Types of Work Breakdown Structures:

- Program Work Breakdown Structure Encompasses Entire Program and Consists of Atleast Three Levels of the Program
  - Used by Government to Define the Contract WBS
  - Used by Contractors to Develop and Extend a Contract WBS
- Contract Work Breakdown Structure is the Approved WBS for Reporting Purposes and its Discretionary Extension by the Contractor
  - Includes All the Elements for the Products Which are Responsibility of the Contractor
  - Contract Work Statement should Provide the Reporting Requirements

WBS LEVELS

- Level 1
  - Entire System
  - Program Element, Project or Subprogram
- Level 2
  - Major Elements of the System
  - Top Level Aggregations of Services or Data
- Level 3
  - Subordinate Items to Level 2 Elements
  - Generally Common Across Similar Programs

PROGRAM WBS (EXAMPLE)



EXPANDED PROGRAM WBS (EXAMPLE)

PROGRAM WBS

1	2	3	4	5
FX AIRCRAFT				
	AIR VEHICLE			
		AIRFRAME		
		PROPULSION (SK-PW-52D)		
		COMMUNICATIONS/IDENTIFICATION		
		NAVIGATION/GUIDANCE		
		FIRE CONTROL		
			RADAR	
				RECEIVER
				TRANSMITTER
				ANTENNA
				RADAR APPLICATIONS S/W (TO CSCI LEVEL)
				RADAR SYSTEM S/W (TO CSCI LEVEL)
				RADAR INTEG., ASSEMBLY, TEST AND CHKOUT
		AUTOMATIC FLIGHT CONTROL		
		CENTRAL COMPUTER		
		ELECTRONIC WARFARE		
		WEAPON DELIVERY EQUIPMENT		
		ARMAMENT		
	SYSTEM TEST AND EVALUATION			
		DEVELOPMENT TEST AND EVALUATION		
		OPERATIONAL TEST AND EVALUATION		
		MOCKUPS		
		TEST AND EVALUATION SUPPORT		
		TEST FACILITIES		
	SYSTEMS ENGINEERING/PROGRAM MANAGEMENT			
		SYSTEMS ENGINEERING		
		PROGRAM MANAGEMENT		
		INTEGRATED LOGISTIC SUPPORT		
	PECULIAR SUPPORT EQUIPMENT			
		TEST AND MEASUREMENT EQUIPMENT		
		SUPPORT AND HANDLING EQUIPMENT		
	COMMON SUPPORT EQUIPMENT			
	TRAINING			
		MAINTENANCE TRAINERS		
		AIRCREW TRAINING DEVICE		
		TRAINING COURSE MATERIALS		
	DATA			
		TECHNICAL PUBLICATIONS		
		ENGINEERING DATA		
		MANAGEMENT DATA		
		SUPPORT DATA		
		DATA DEPOSITORY		
	OPERATIONAL/SITE ACTIVATION			
		CONTRACTOR TECHNICAL SUPPORT		
	INITIAL SPARES AND REPAIR PARTS			

AUTOMATED SOFTWARE SYSTEM WORK BREAKDOWN STRUCTURE

LEVEL 1	LEVEL 2	LEVEL 3
Electronic/Automated Software System	Prime Mission Product (PMP)	Electronic Subystem 1 ..n (Specify Names) PMP Applications Software PMP System Software PMP Integration, Assembly, Test and Checkout
	Platform Integration	
	System Engineering/Program Management	
	System Test and Evaluation	Development Test and Evaluation Operational Test and Evaluation Mock-ups Test and Evaluation Support Test Facilities
	Training	Equipment Services Facilities
	Data	Technical Publications Engineering Data Management Data Support Data Data Depository

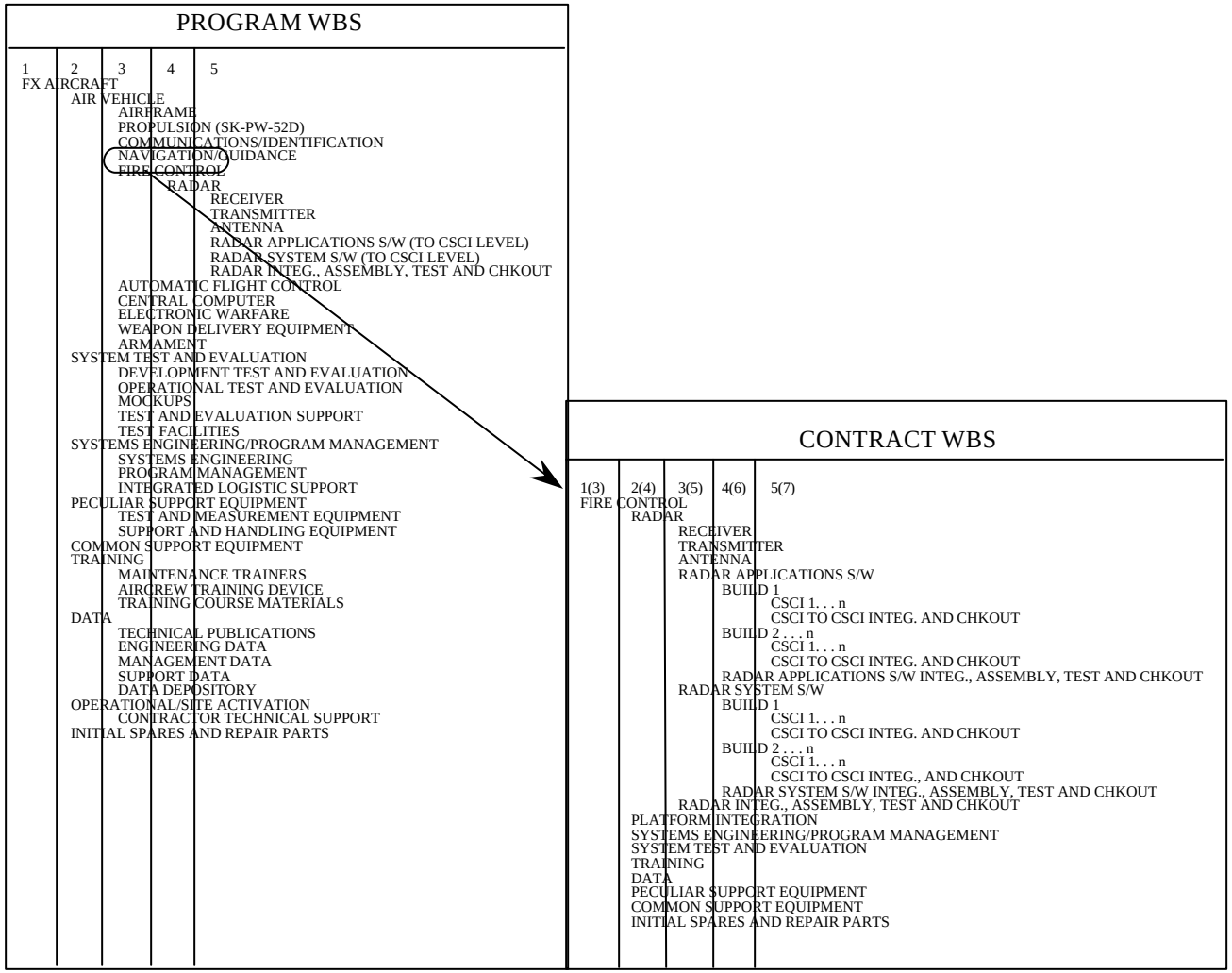
AUTOMATED SOFTWARE SYSTEM
WORK BREAKDOWN STRUCTURE (CONT'D)

LEVEL 1	LEVEL 2	LEVEL 3
	Peculiar Support Equipment	Test and Measurement Equipment Support and Handling Equipment
	Common Support Equipment	Test and Measurement Equipment Support and Handling Equipment
	Operational/Site Activation	System Assembly, Installation and Checkout on Site Contractor Technical Support Site Construction Site/Ship/Vehicle Conversion
	Industrial Facilities	Construction/Conversion/Expansion Equipment Acquisition or Modernization Maintenance (Industrial Facilities)
	Initial Spares and Repair Parts	

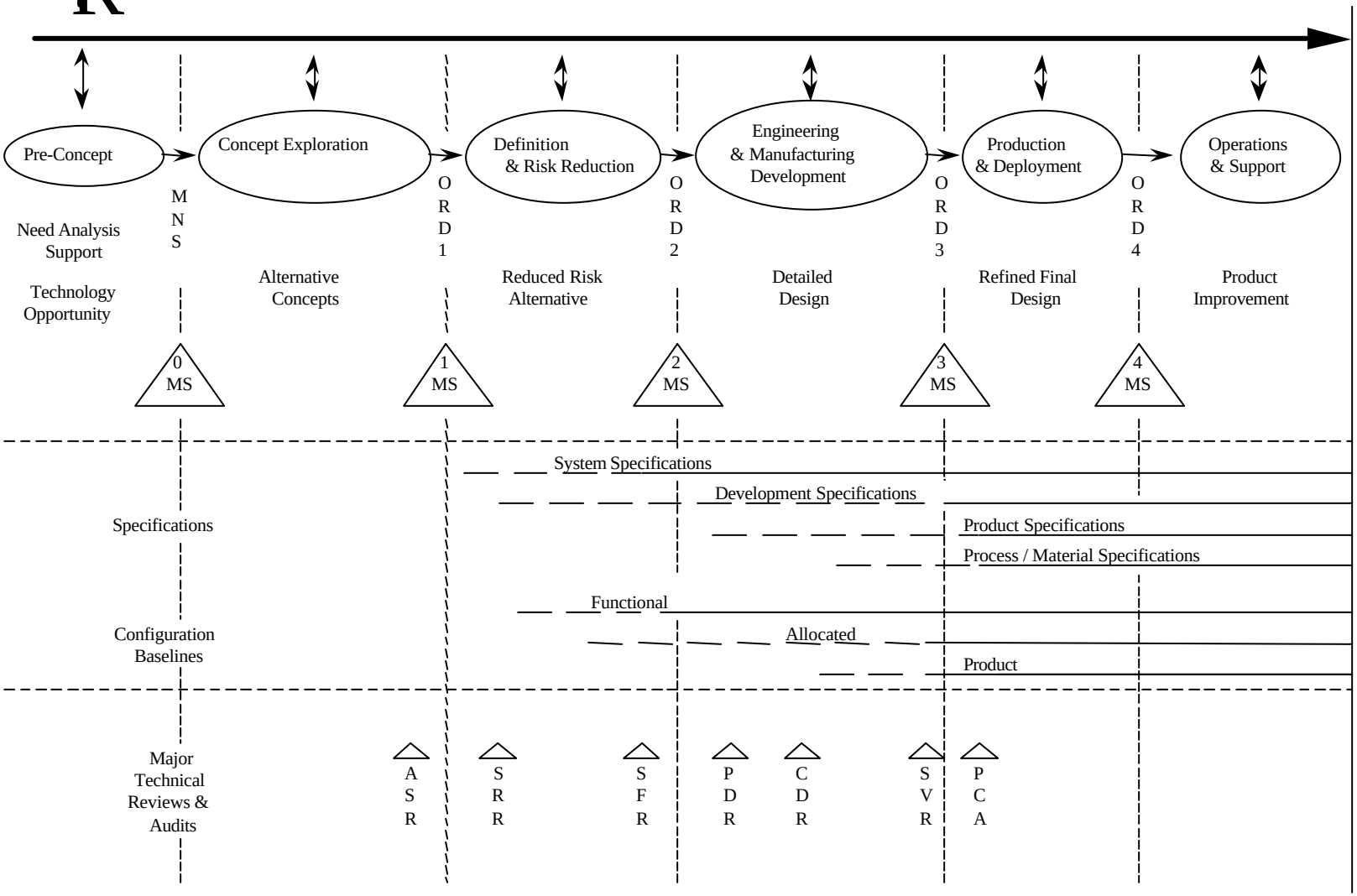
AUTOMATED SOFTWARE SYSTEM
WORK BREAKDOWN STRUCTURE (CONT'D)
Software Extension

LEVEL 4	LEVEL 5	LEVEL 6
Build 1…n	CSCI 1	CSC 1…n CSC to CSC Integration and Checkout
	CSCI 2	CSC 1…n CSC to CSC Integration and Checkout
	CSCI 3	CSC 1…n CSC to CSC Integration and Checkout
	CSCI to CSCI Integration and Checkout	

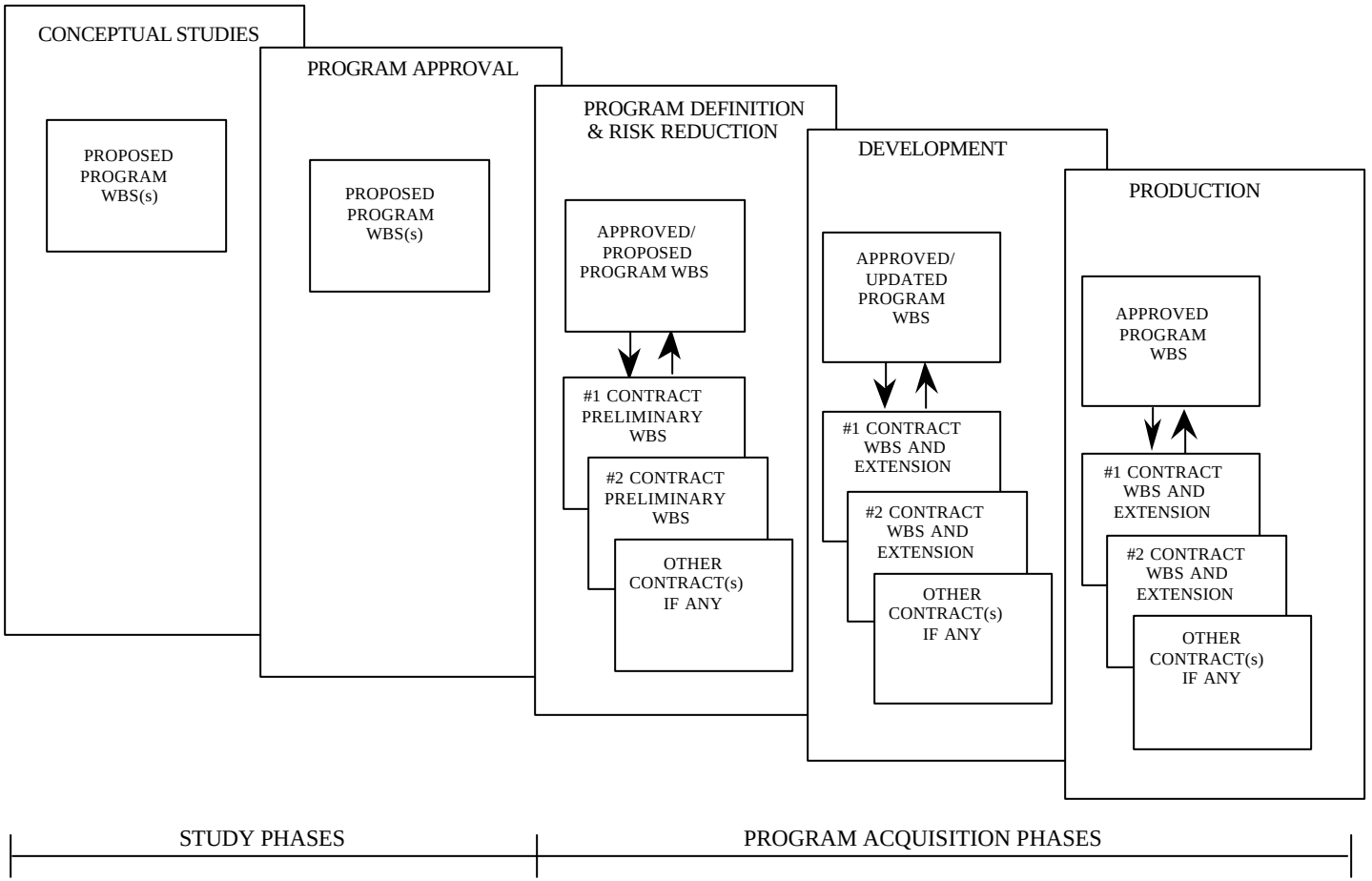
RELATIONSHIP OF PROGRAM WBS WITH CONTRACT WBS



EVOLUTIONARY REQUIREMENTS DEFINITION



THE EVOLUTION OF WORK BREAKDOWN STRUCTURE



SYSTEMS DEVELOPMENT
Mission Need and Analysis

MCR

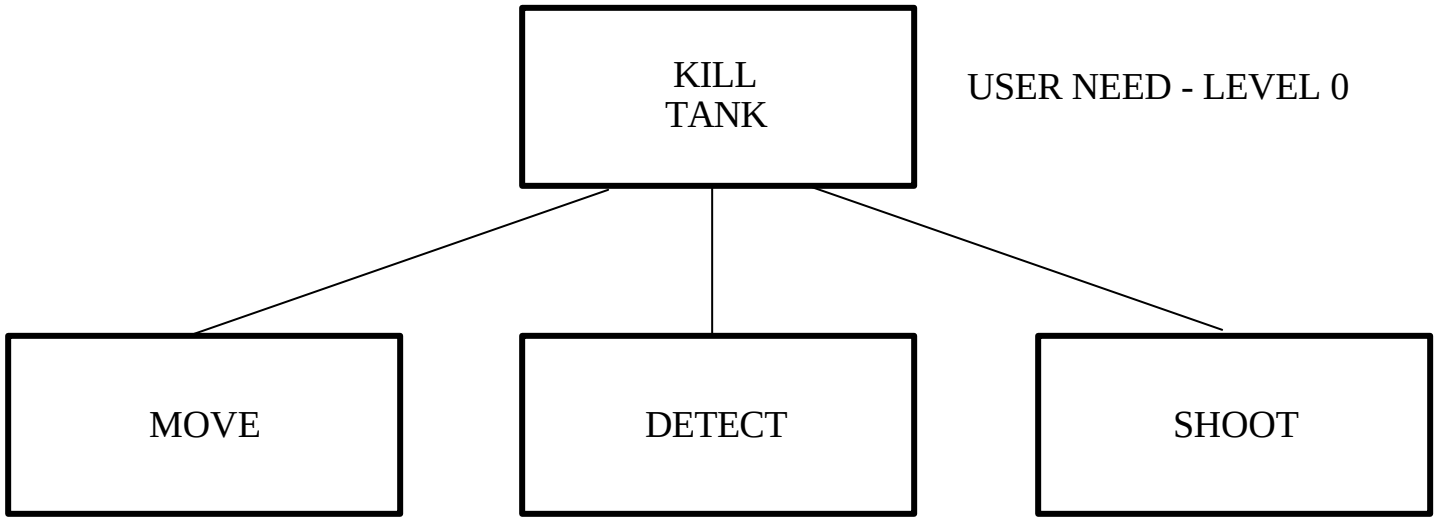
SYSTEMS ENGINEERING

- Pre-Concept
  - Need Analysis Support
  - Identifying Technology
  - Systems Engineering Intensive
- Concept Exploration
  - Mission Need Statement
  - Exploratory Trade-Off Studies
  - Preliminary System Level
    - Functions
    - Performance
  - Top Level Specifications

WBS DEVELOPMENT

- No Formal WBS Defined

CONCEPT EXPLORATION



PROGRAM DEFINTION & RISK REDUCTION

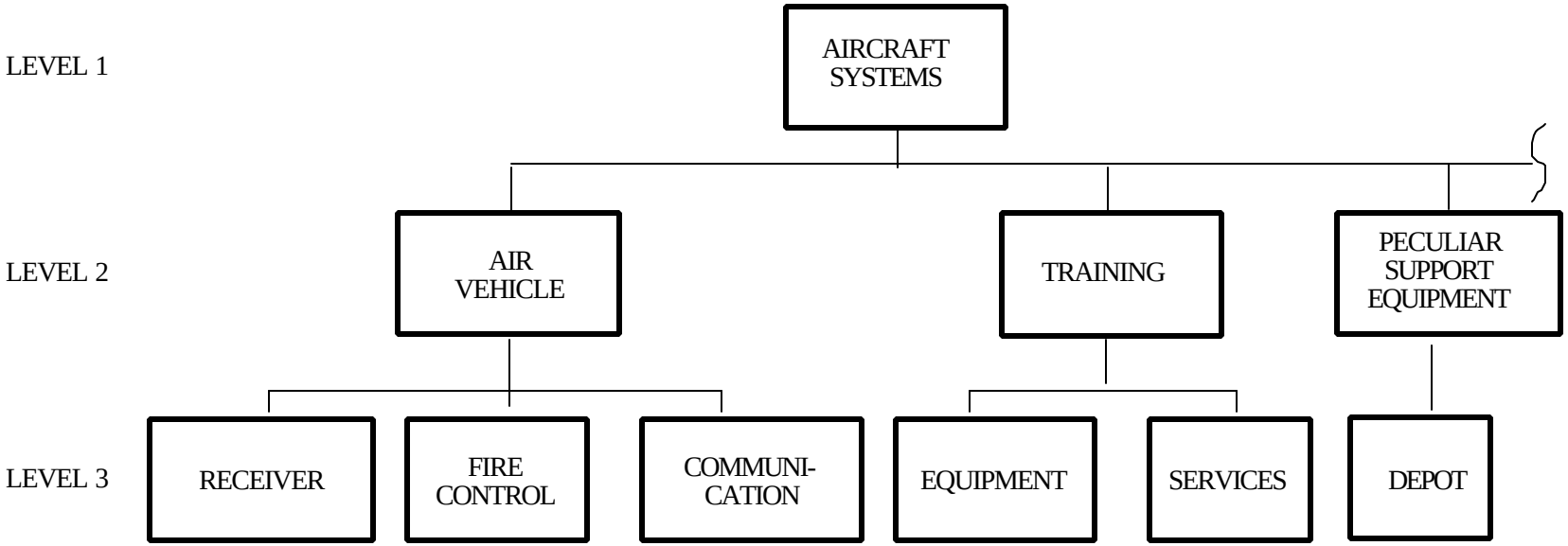
SYSTEMS ENGINEERING

- Operational Requirements Document (ORD)
  - Approved Program
- System Level Performance Requirements
  - Prove Critical Technologies and Processes
  - Type”A” or “B” Specifications
- CAIV Implementation
- Preliminary Configuration Items Within a Functional Architecture
- Preparation of Statement of Objectives

WBS DEVELOPMENT

- Preparation of:
  - CCDR Plan
  - Preliminary Program WBS to Level 3
  - Schedule and Cost Estimates
- Prepare CAIV Trade-offs for each WBS element

PROGRAM DEFINITION & RISK REDUCTION



ENGINEERING & MANUFACTURING DEVELOPMENT

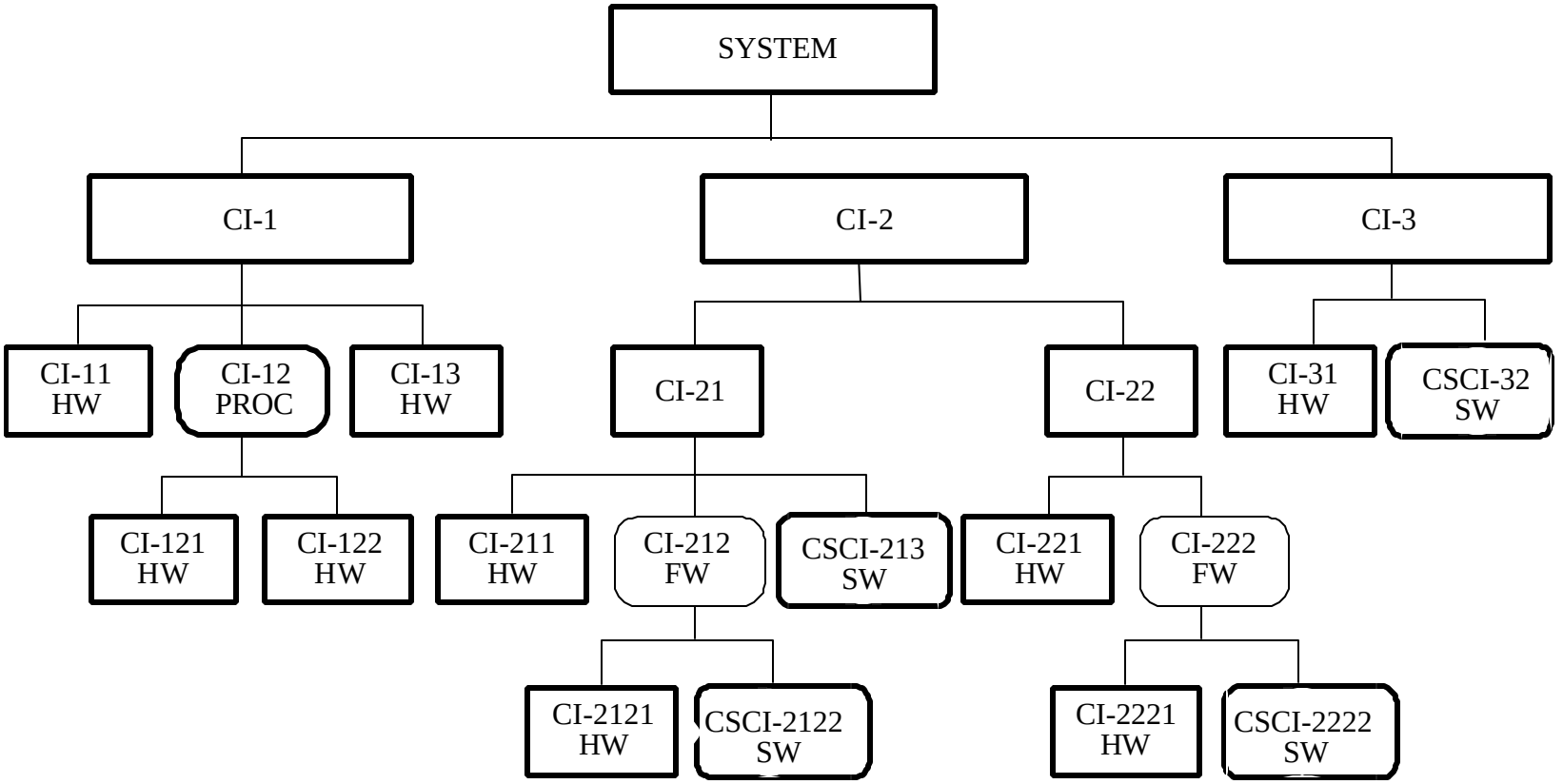
SYSTEMS ENGINEERING

- Updated Operational Requirements Document
- Detailed Design
  - Preliminary Design Review
  - Critical Design Review
  - Lower Level Specification
  - Product and Process/Material Specifications
- Configuration Defined
  - Specification Tree
  - Configuration Items (CI) or Computer Software Configuration Item (CSCI)
- Cost/Performance Trade-offs

WBS DEVELOPMENT

- Approved Program WBS
- Statement of Work Developed by Contractor
- Approved Contract WBS
- Extension of Contract WBS by Contractor
- Continue CAIV Trade-offs
- Cost/Schedule Performance Measurement

SYSTEM CONFIGURATION



PRODUCTION

SYSTEMS ENGINEERING

- Produce Prime Mission Product
- Maintain Configuration Management
- Improve Performance through CAIV implementation

WBS DEVELOPMENT

- Maintain Program and Contract WBS
  - Major Modifications
  - Relationship to Process and Configuration Control
- Continue CAIV Trade-offs
- Cost/Schedule Reporting

USES OF A WORK BREAKDOWN STRUCTURE

- Technical Management
  - Provides Framework for Defining the Technical Objectives of the Program
  - Together with Contract SOW and Product Specification, Aids in Establishing a Specification Tree, Defining Configuration Items, and Planning Support Tasks
  - Contract Statement of Work (SOW)
  - Describes What Products and Services are to be Delivered
  - An Effective SOW will Facilitate Effective Contractor Evaluation After Contract Award
  - A Standardized WBS is a Template for Constructing the SOW and the Contract Line Items (CLINs) - Streamline the Process
  - Use the WBS to Provide the Framework and Facilitate a Logical Arrangement of the SOW Elements
- Specification Tree
  - Hierarchy of Performance Requirements for Each Component Element of the System for Which Design Responsibility is Assigned
  - Specifications May Not be Written for Each Product
  - May Not Match the WBS

USES OF A WORK BREAKDOWN STRUCTURE (CONT'D)

- Configuration Management
  - Process of Managing the Technical Configuration of Items Being Developed
  - Need to Designate Which Contract Deliverables are Subject to Configuration Management Controls
    - Configuration Item (CI)
    - Computer Software Configuration Item (CSCI)
  - Framework for Designating the Configuration Items in the WBS
- Financial Management
  - WBS Assists Management in Measuring Cost and Schedule Performance
  - Products are Identified in Terms of Cost and Schedule Performance Goals
  - Serves as the Basis for Estimating and Scheduling Resource Requirements
- Cost Estimating
  - Facilitates Government to Plan, Coordinate, Control and Estimate Various Program Activities
  - Provides Common Framework for Tracking Estimated and Actual Costs

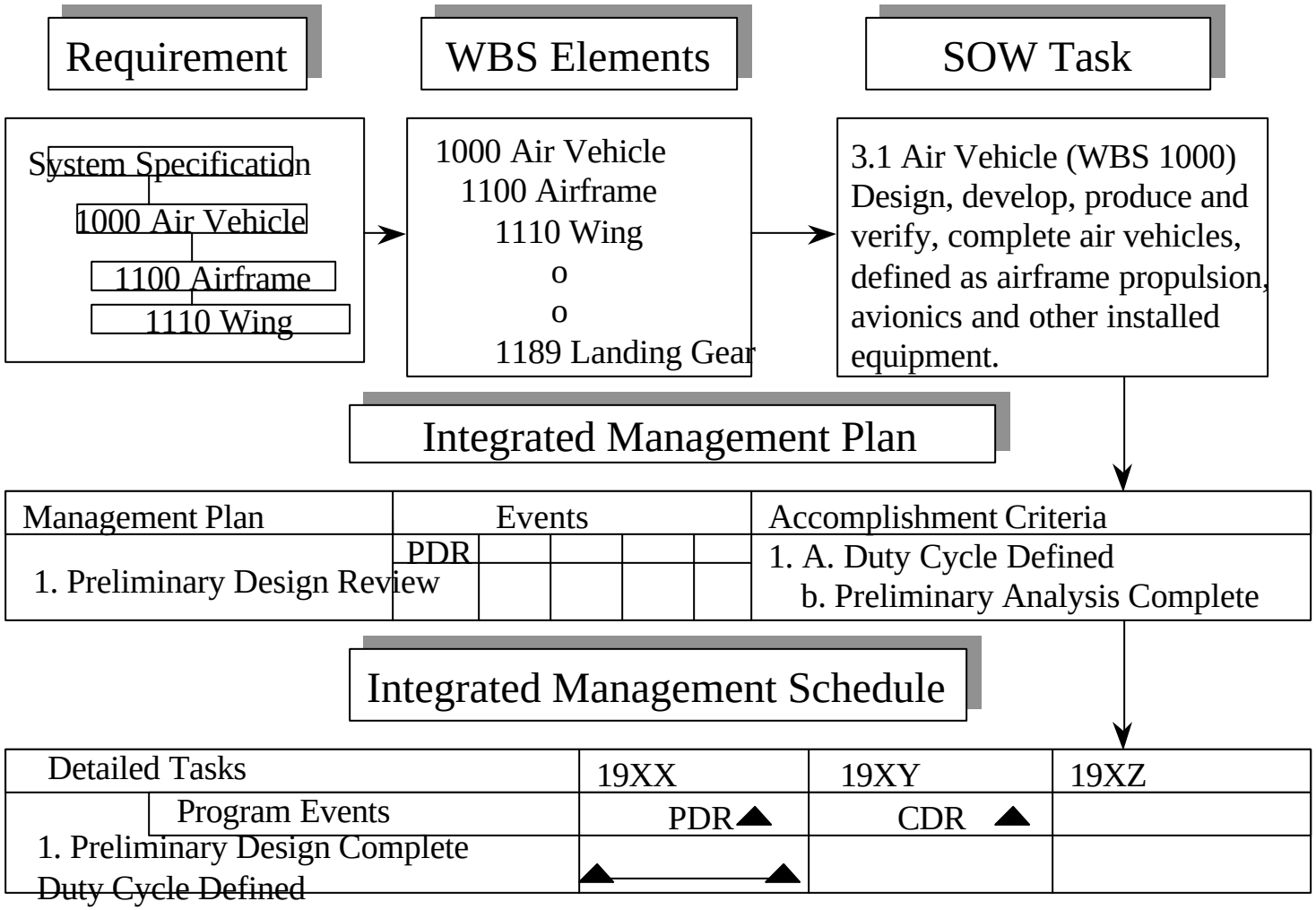
USES OF A WORK BREAKDOWN STRUCTURE (CONT'D)

- Data Bases
  - Used for Pricing and Negotiating Contracts and Contract Changes, and for Follow-on Procurement
  - Provides Cost Data Base of Similar WBS Elements from Different Programs
    - Used to Develop Learning Curves, Regression and Other Techniques to Estimate the Cost Requirements
    - Provide Comparison to the Original Estimates
    - Assists in Bidding Future Contracts and Budgeting New Work

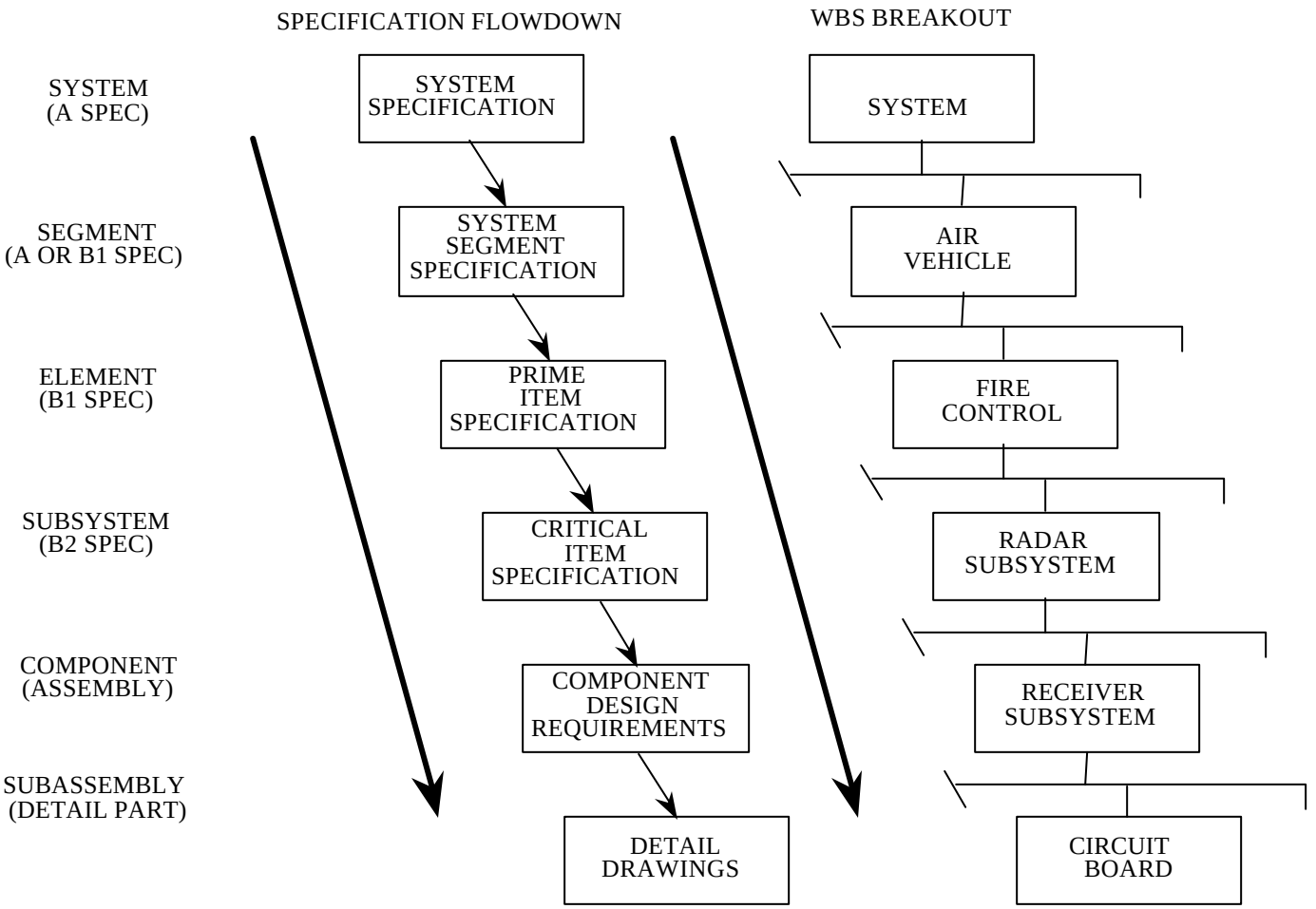
RELATIONSHIP TO MANAGEMENT PLAN AND SCHEDULE

- Project Control Is the First Unit of Control
  - Integrated Management Plan (IMP) Ties Contractual Work Scope With Technical Plans and Goals of the Program
- Time or Schedule Is the Second Unit of Control
  - Integrated Management Schedule (IMS) Ties Contractual Work Scope to Schedule or Milestones Goals
  - Understanding the Duration to Go From Step One to Step Two of the Work Scope the Better the Plan and the Better the Control
- Identifying Resources Is the Third Unit of Control
  - Identifying Materials, People and Tools to the Work Scope Definition Will Determine How Well the Project Is Utilizing Resources and How Performance Is Measured.

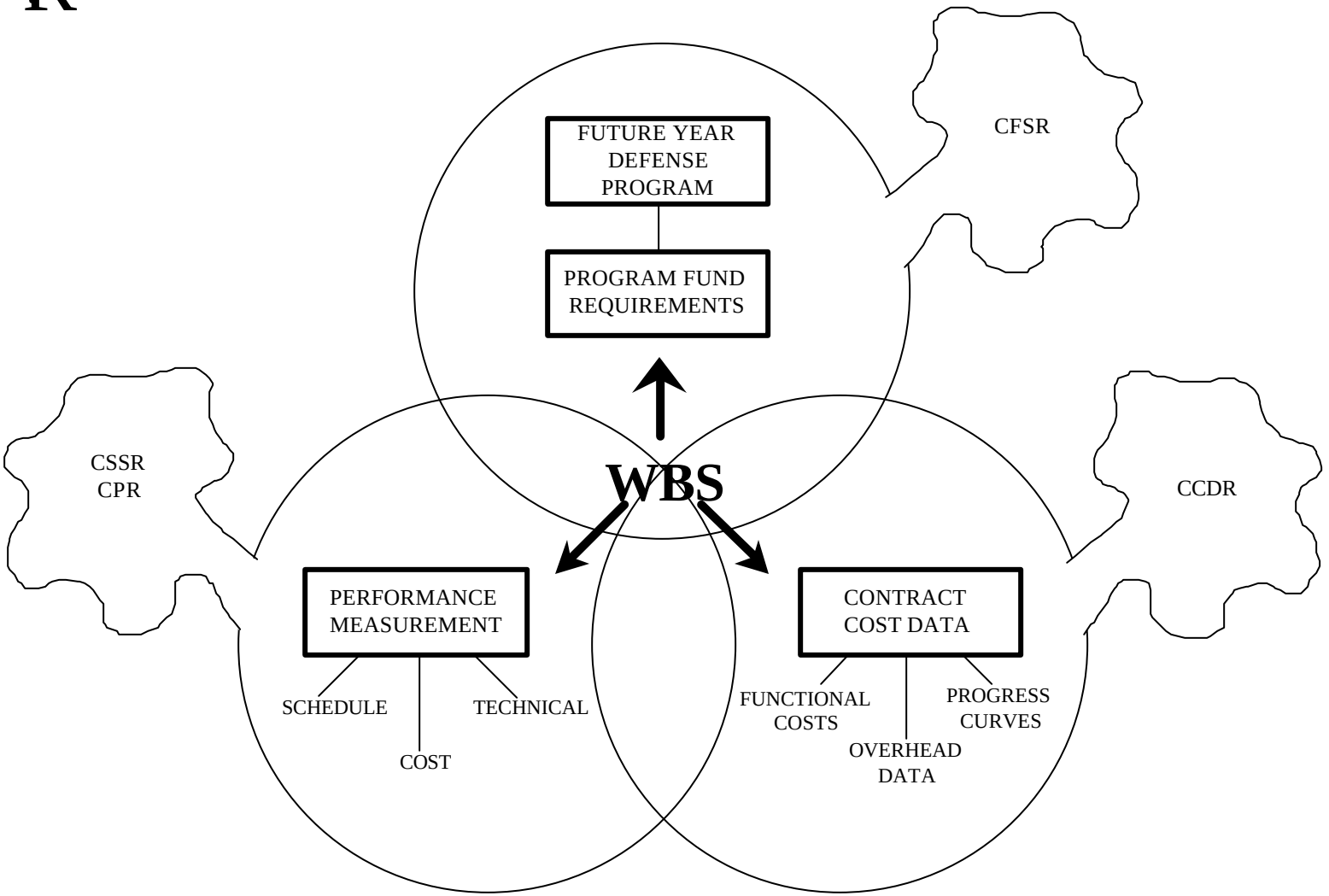
INTEGRATED MANAGEMENT



RELATIONSHIP OF SYSTEM DESIGN AND WBS



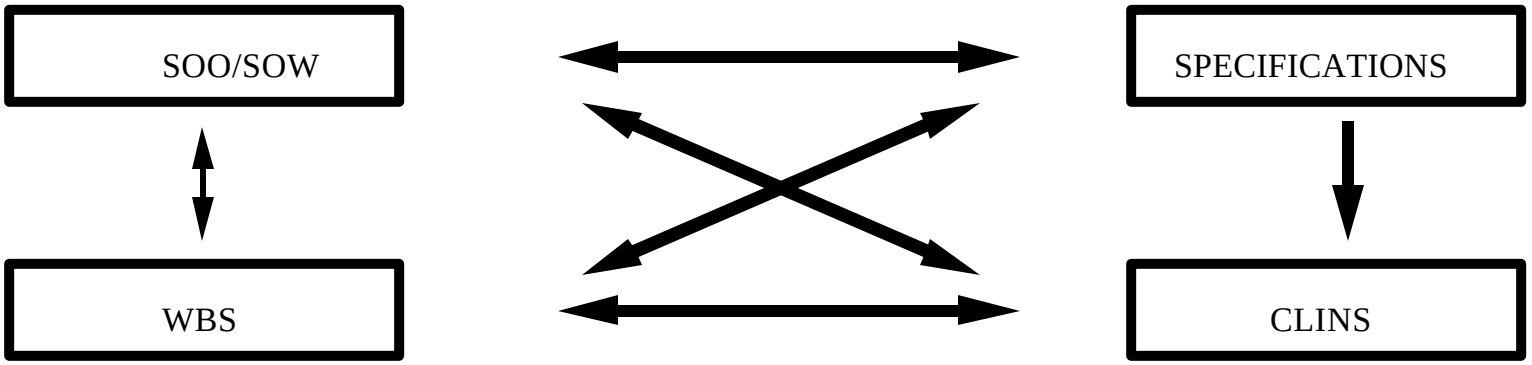
FINANCIAL MANAGEMENT REPORTING STRUCTURE



INTEGRATING PROGRAM ACQUISITION REQUIREMENTS

- Generated by Government
- Identifies Work to be Performed

- Define the System



- Ties System Definition with Work to be Performed
- Conforms to MIL-HDBK
- Framework for Technical, Cost, Schedule Reporting

- Identifies Contractual Requirements
- Tied to SOO/SOW or WBS

CONTRACT BUSINESS MANAGEMENT OVERVIEW

- RFPs Identify Significant “Misapplication” of Reporting Requirements
  - Timely Development of CCDR Data Plan
  - CCDRs Not Used; Go To Unknown Staff
  - WBS Changes After Contract Award
  - Drive Reporting to Too Low of Level
  - Tailoring Not Allowed
  - CLINs Cause Separate Allocation
- 50% Have WBS Implementation Problems
  - Poor Software WBS Definition
  - WBS Not oriented to Development Type Contracts
  - Conflicts Between Types of WBS Used
  - Extending WBS Below Reporting Level Requires Permission

CONTRACT BUSINESS MANAGEMENT OVERVIEW (CONT'D)

- Program Manager Involvement
  - Key Individual in Process
  - Upfront Planning Drives Quality of Output
  - Business Planning Ownership Should Not be Diffused
- Poor Communication
  - Industry/Government Relationship
  - WBS Development Inconsistent Across Services
  - WBS Must be the Tool for Integrating the Functions and Communicating the Needs

GAO REPORTFINDINGS
May 1997

- Found contractor systems inconsistent with Government requirements for reporting
- Levels of reporting were often too low
- Disconnect between cost account and development processes
- Estimating and C/S requirements out of sync
- CCDR procedures and processes being revised
- Standardized WBS could provide consistency (but could cause problems if improperly implemented)

ISSUES IN WORK BREAKDOWN STRUCTURE DEVELOPMENT

- Element of a Program that are Not Products
- Program Phases (e.g., Production), and Types of Funds (e.g., Research, Development, Test and Evaluation)
- Rework, Retesting and Refurbishing
- Non-recurring and Recurring Classifications
- Organizational Structure (Functional vs. IPT)
- Tooling (e.g., Special Test Equipment, and Factory Support Equipment Such as: Assembly Tools, Dies Jigs, Fixtures, Handling Equipment, etc.)
- Production Acceptance Testing of R&D (Including First Article Test) and Production Units

ISSUES IN WORK BREAKDOWN STRUCTURE DEVELOPMENT

- The Integrated Management Plan (IMP) and Integrated Management Schedule (IMS) should reflect the WBS
- The IMP/IMS data contained within the CWBS framework should be reconcilable into a single IMP/IMS element.
- The WBS will serve multiple functions within the program. Design of the WBS should accommodate the requirements for:
  - Design To Cost (DTC)/Life Cycle Cost (LCC), Cost As an Independent Variable (CAIV)
  - Engineering Bill(s) of Material (EBOM), Manufacturing Bill(s) of Material (MBOM),
  - Product structure of the end items regardless of phase or funding
- Each subcontractor effort will be assigned to a single WBS element
  - Minor subcontractors (i.e., subcontractors with either little or no technical, schedule, and/or cost risk) may be grouped together under a single WBS element

COMPARISON OF CORRECT AND INCORRECT PROGRAM WBSs

CORRECT

PROGRAM WBS

1	2	3	4
FX AIRCRAFT			
	AIR VEHICLE		
		AIRFRAME	
			WING
			FUSELAGE
			EMPENNAGE
			FLIGHT CONTROLS SUBSYSTEM
			HYDRAULIC SYSTEM
			ENVIRONMENTAL CONTROL
			CREW STATION SYSTEM
			LANDING AND ARRESTING GEAR SYSTEM
			INTEG., ASSEMBLY, TEST AND CHKOUT
		PROPULSION (SK-PW-52D)	
		COMMUNICATIONS/IDENTIFICATION	
			RADIO SYSTEM
			DATA LINK
			COMMUNICATIONS SYSTEM SOFTWARE
		NAVIGATION/GUIDANCE	
		FIRE CONTROL	
			RADAR
			COMPUTER
			CONTROLS AND DISPLAYS
			SYSTEM SOFTWARE
		AUTOMATIC FLIGHT CONTROL	
		CENTRAL COMPUTER	
			COMPUTER
			SYSTEM SOFTWARE
		ELECTRONIC WARFARE	
		WEAPON DELIVERY EQUIPMENT	
		ARMAMENT	
	SYSTEM TEST AND EVALUATION		
		DEVELOPMENT TEST AND EVALUATION	
			WIND TUNNEL ARTICLES AND TEST
			STATIC ARTICLES AND TEST
			FATIGUE ARTICLES AND TEST
			CONTRACTOR FLIGHT TESTS
		OPERATIONAL TEST AND EVALUATION	
		MOCKUPS	
		TEST AND EVALUATION SUPPORT	
		TEST FACILITIES	
	SYSTEMS ENGINEERING/PROGRAM MANAGEMENT		
		SYSTEMS ENGINEERING	
		PROGRAM MANAGEMENT	
		INTEGRATED LOGISTIC SUPPORT	
	PECULIAR SUPPORT EQUIPMENT		
		TEST AND MEASUREMENT EQUIPMENT	
		SUPPORT AND HANDLING EQUIPMENT	
	COMMON SUPPORT EQUIPMENT		
	TRAINING		
		MAINTENANCE TRAINERS	
		AIRCREW TRAINING DEVICE	
		TRAINING COURSE MATERIALS	
	DATA		
		TECHNICAL PUBLICATIONS	
		ENGINEERING DATA	
		MANAGEMENT DATA	
		SUPPORT DATA	
		DATA DEPOSITORY	
	OPERATIONAL/SITE ACTIVATION		
		CONTRACTOR TECHNICAL SUPPORT	
	INITIAL SPARES AND REPAIR PARTS		

INCORRECT

PROGRAM WBS

1	2	3	4	5
FX AIRCRAFT				
	AIR VEHICLE			
		AIRFRAME		
			DESIGN ENGINEERING	
			FABRICATION	
			ASSEMBLY	
		PROPULSION (SK-PW-52D)		
		COMMUNICATION/IDENTIFICATION		
			MANUFACTURING	
			ENGINEERING	
			QUALITY ASSURANCE	
			MATERIAL	
		NAVIGATION/GUIDANCE		
		FIRE CONTROL		
			NONRECURRING	
			RECURRING	
		AUTOMATIC FLIGHT CONTROL		
		CENTRAL COMPUTER		
		ELECTRONIC WARFARE		
		WEAPON DELIVERY EQUIPMENT		
		ARMAMENT		
		SOFTWARE		
			COMMUNICATIONS/IDENTIFICATION SOFTWARE	
			FIRE CONTROL SOFTWARE	
			NAVIGATION/GUIDANCE SOFTWARE	
			AUTOMATIC FLIGHT CONTROL SOFTWARE	
			CENTRAL COMPUTER SOFTWARE	
			ELECTRONIC WARFARE SOFTWARE	
	SYSTEM TEST AND EVALUATION			
		PRODUCTION ACCEPTANCE TEST		
		FIRST ARTICLE TEST		
		DEVELOPMENT TEST AND EVALUATION		
		OPERATIONAL TEST AND EVALUATION		
		MOCKUPS		
		TEST AND EVALUATION SUPPORT		
		TEST FACILITIES		
	SYSTEMS ENGINEERING/PROGRAM MANAGEMENT			
		TRAINING COURSE MATERIALS		
	DATA			
		TECHNICAL PUBLICATIONS		
		ENGINEERING DATA		
		MANAGEMENT DATA		
		SUPPORT DATA		
		DATA DEPOSITORY		
	OPERATIONAL/SITE ACTIVATION			
		CONTRACTOR TECHNICAL SUPPORT		
	INITIAL SPARES AND REPAIR PARTS			

WRONG
These are work efforts, not products

WRONG
These items are functional, not products (Ref. CCDR)

WRONG
Nonrecurring and recurring items are not WBS elements (Ref. CCDR)

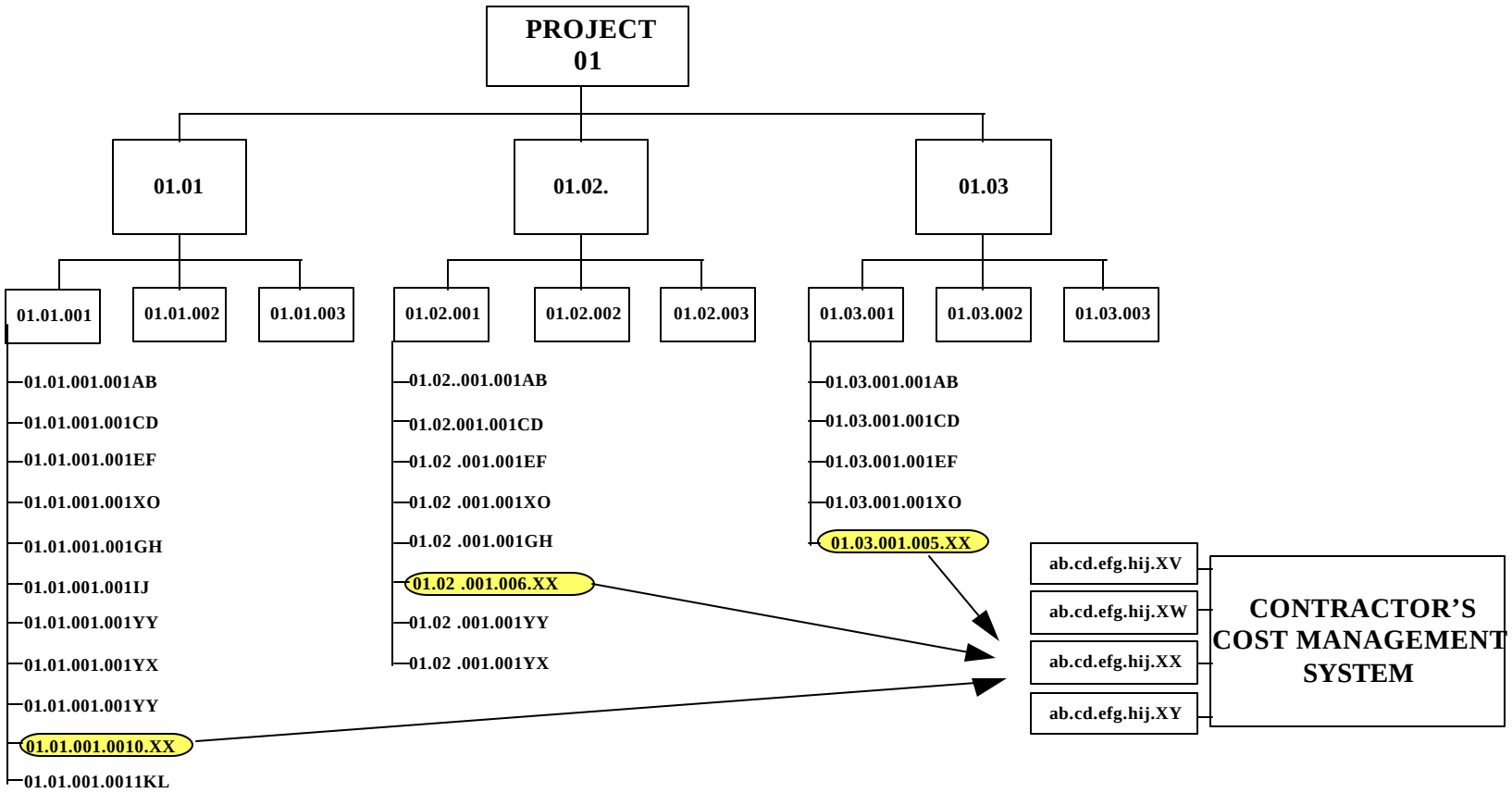
WRONG
Software should be included with the hardware it supports.

WRONG
These are system level tests but should be included in the Airframe WBS element.

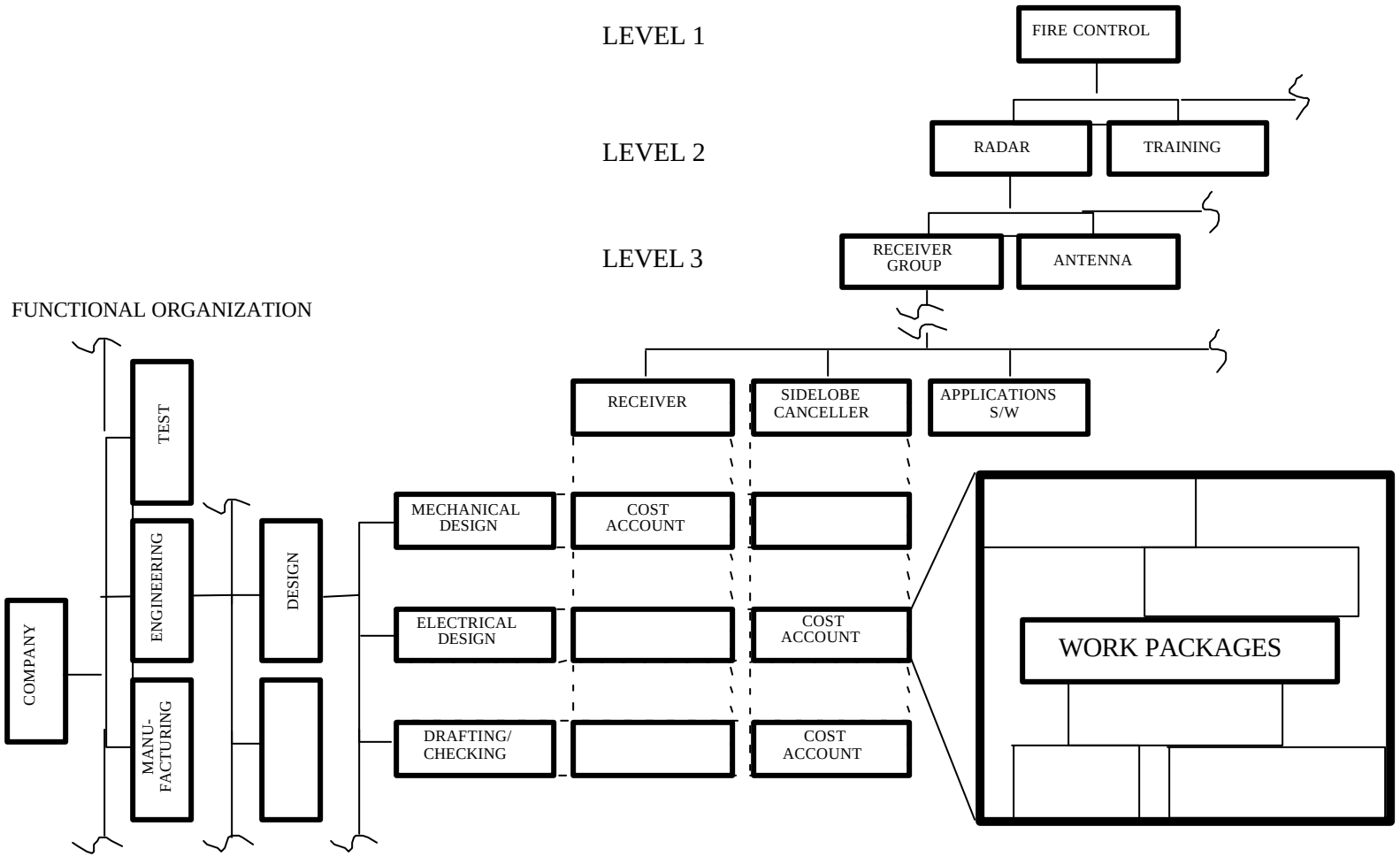
RELATIONSHIP WITH CONTRACTOR MANAGEMENT SYSTEM

- Contractor Should Assign Management Responsibility for Technical, Schedule, and Cost Performance (Cost Account Manager)
  - Cost Management System Should Provide the Necessary Visibility of the WBS as it Interfaces with the Organization
  - At Juncture of the WBS Element and Organization Unit, Cost Accounts are Usually Established
  - Performance is Planned, Measured, Recorded and Controlled

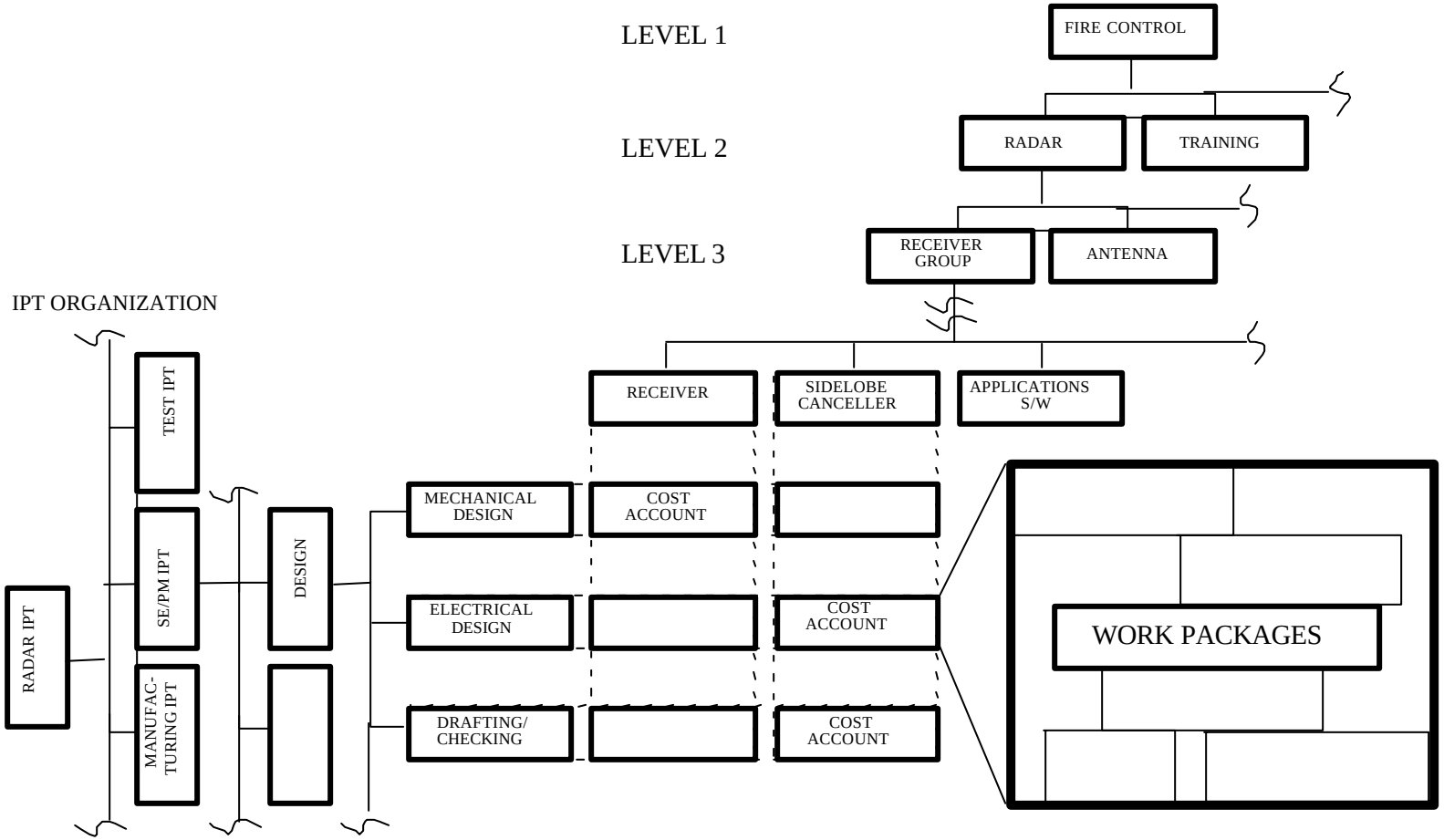
COST MANAGEMENT SYSTEM



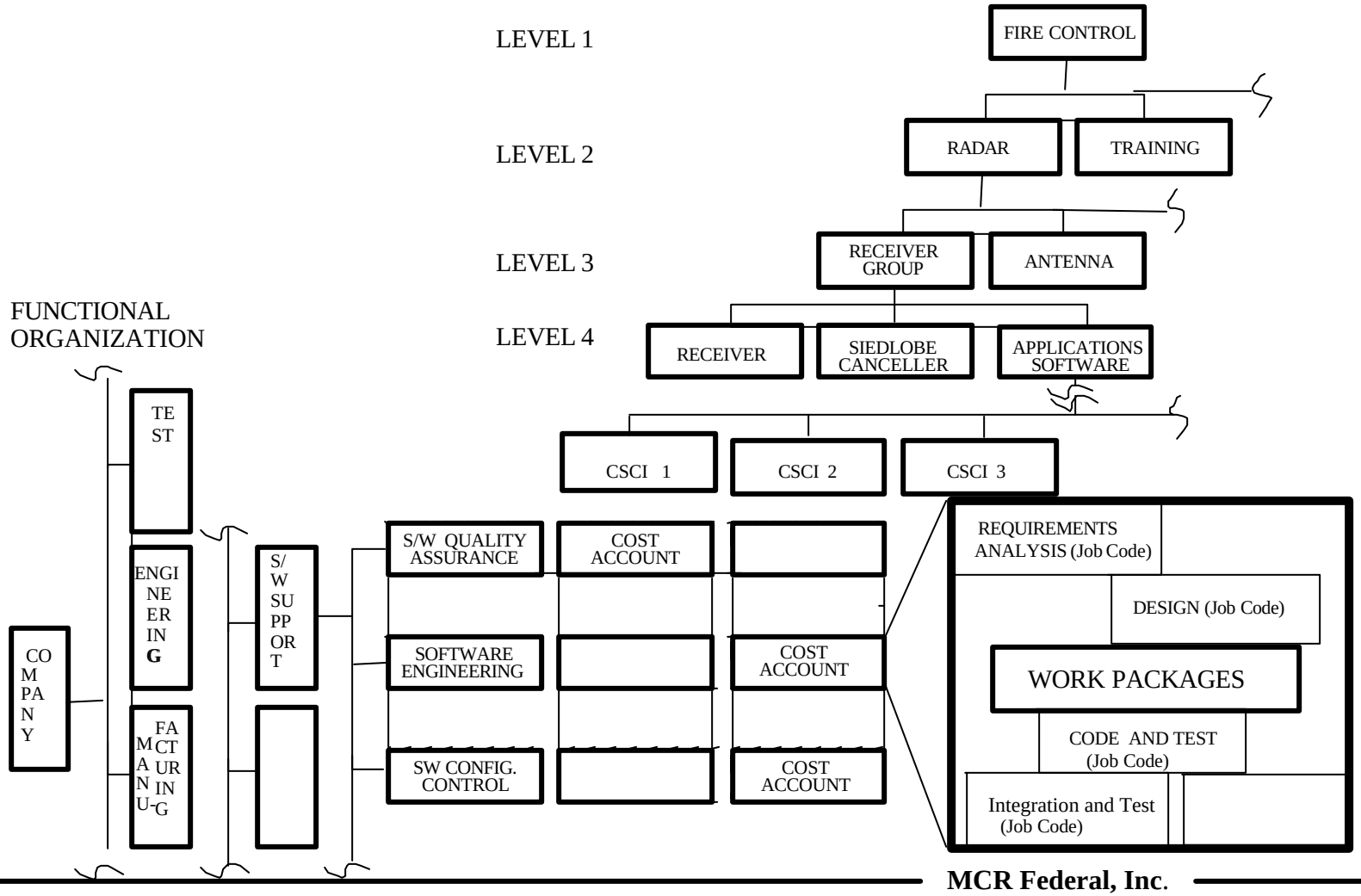
TRANSLATION FROM FUNCTION TO PRODUCT



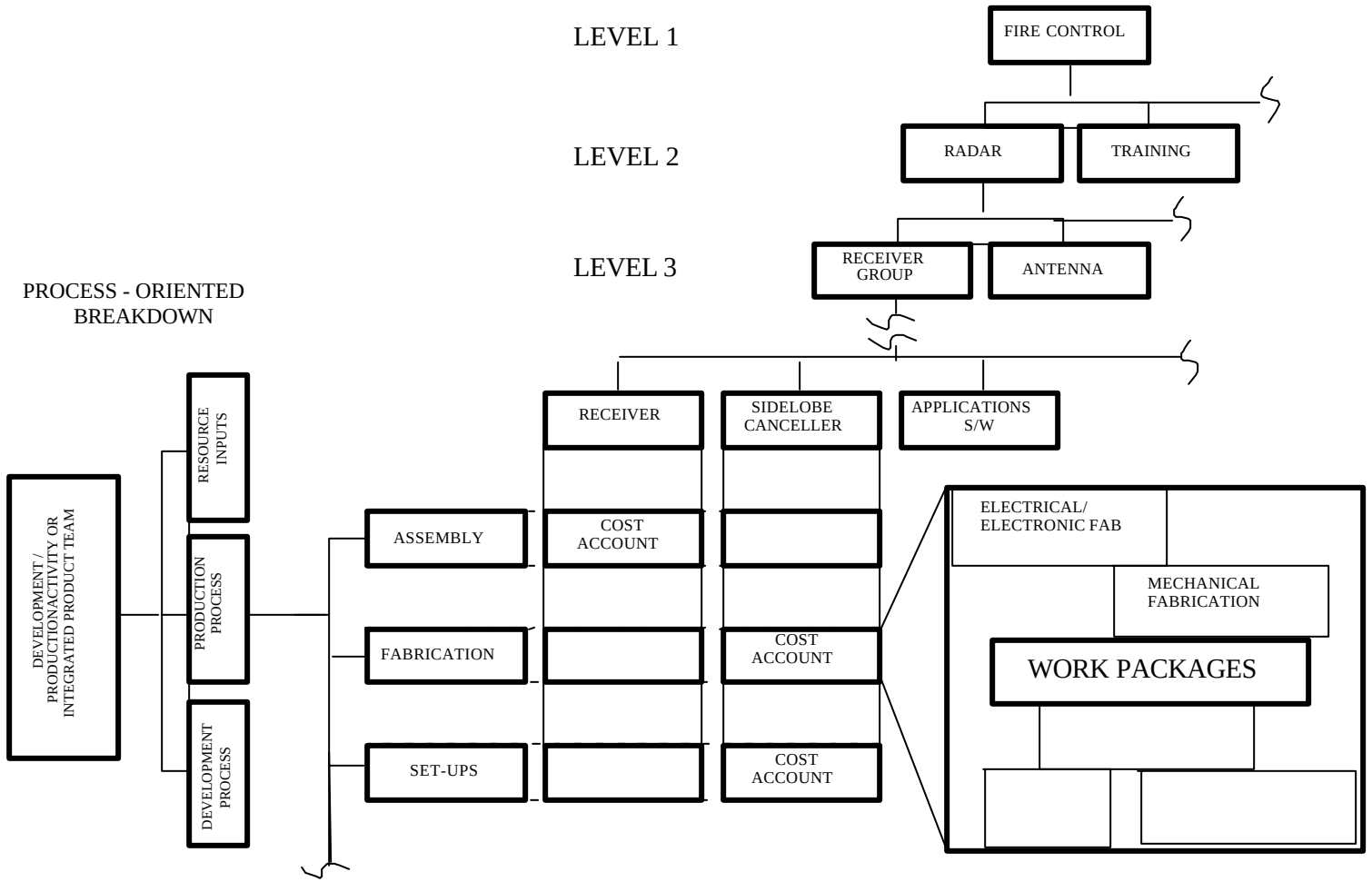
TRANSLATION FROM IPT TO PRODUCT



LINKAGE BETWEEN CONTRACTOR WBS AND CONTRACTOR MANAGEMENT SYSTEMS



LINKAGE BETWEEN WORK BREAKDOWN STRUCTURE AND PROCESS-ORIENTED BREAKDOWN



SUMMARY

- Work Breakdown Structure is Product-Oriented Family Tree
- Develop program and Contract Work Breakdown Structure Based on How the System Will be Developed
- Use the Work Breakdown Structure as an Integrating Tool with the SOW, CLIN and System Design
- Acquisition Reform Provides Continued Use of WBS with IPT, CAIV, IMS, IMP, and Other Initiatives
- Extension of WBS at Too Low of Level Will Burden the Contractor Management System
- Use the WBS as a Medium for Communicating the Program Requirements

THE FUTURE

OF EVMS

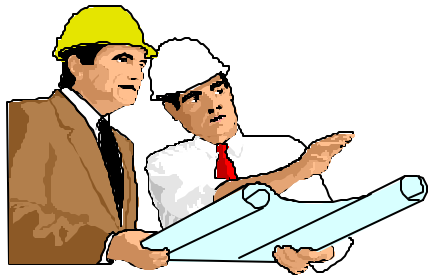
THE FUTURE OF EVMS

October, 1993 - A Vision

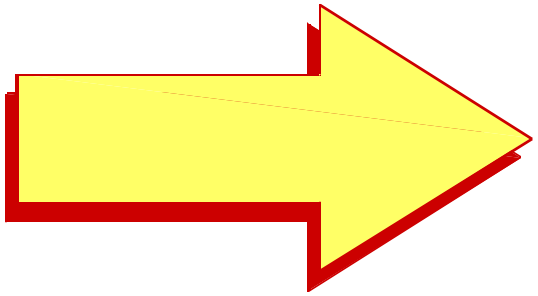
“The quality of a contractor’s management system is determined not by the absence of defects, but by the presence of management value”

THE FUTURE OF EVMS

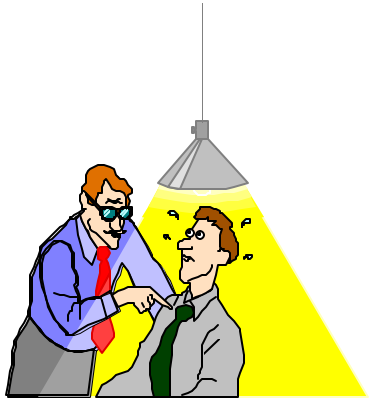
October, 1993 - A Vision



Inspection



Management



THE FUTURE OF EVMS

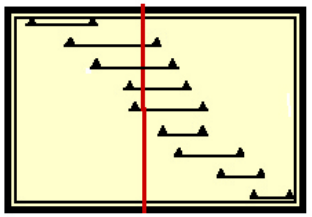
Integration

- Cost
- Schedule
- Technical Performance
- Risk

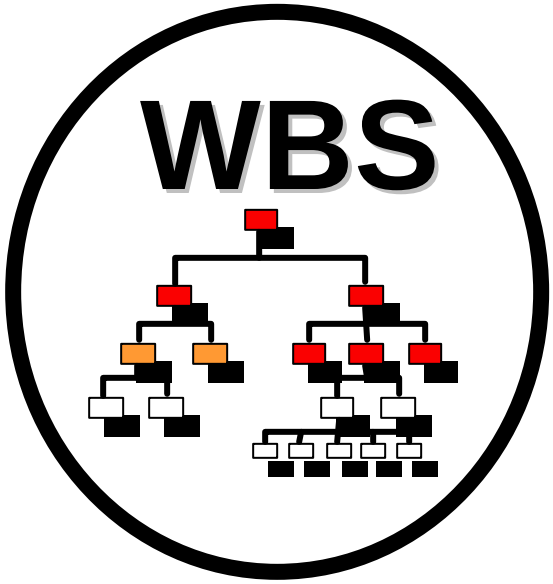
THE FUTURE OF EVMS

Work Breakdown Structure - The Key to Integration

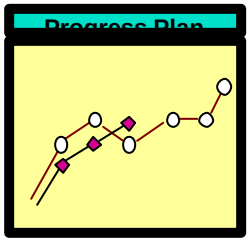
COST



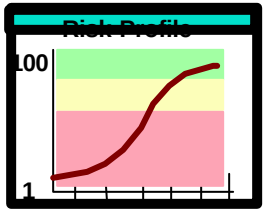
SCHEDULE



TECHNICAL

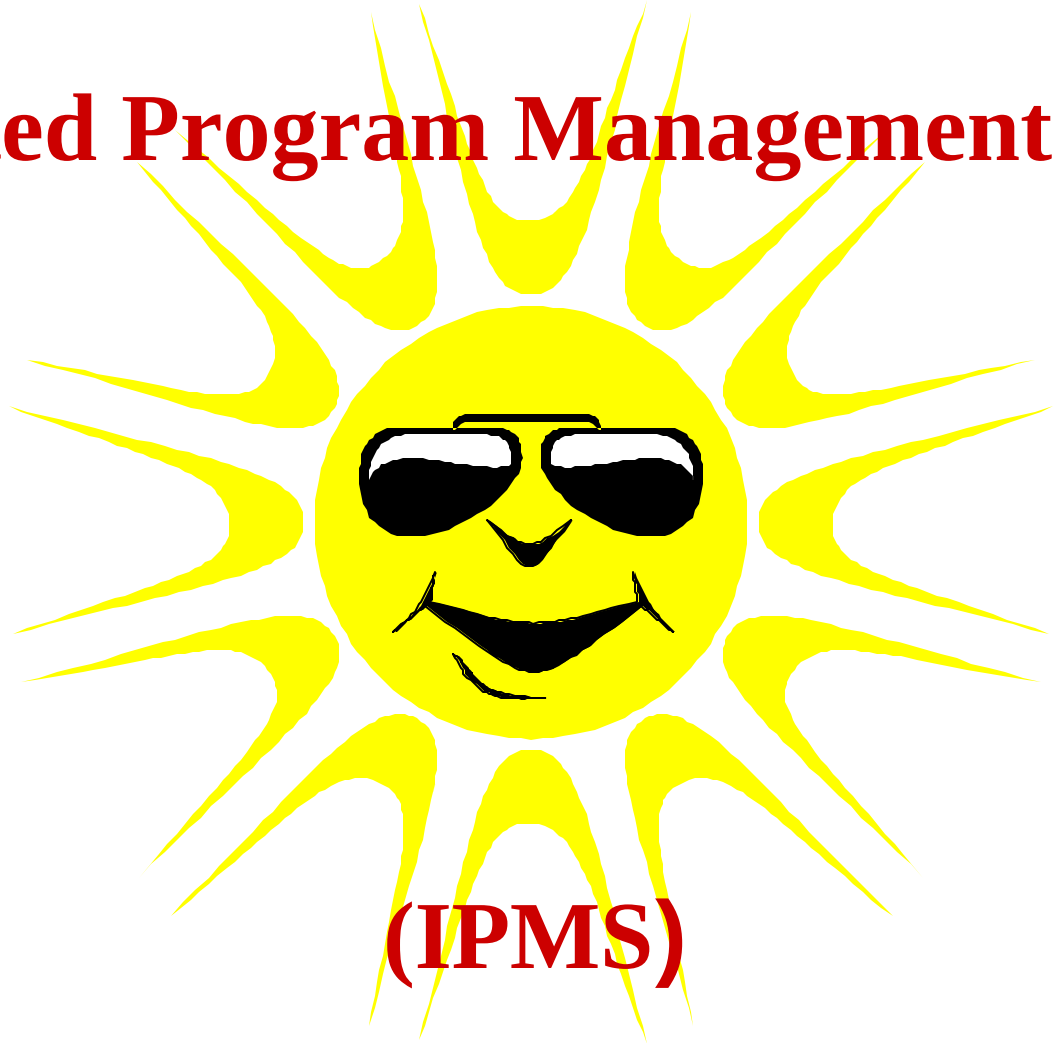


RISK



THE FUTURE OF EVMS

Integrated Program Management Systems



(IPMS)

OMB Circular A-11, Part II: Strategic Plans and Annual Performance Plans

Presented By

Mr.. Walter S. Groszyk, Jr..

Office of Management and Budget (OMB)

(202) 395-3172 groszyk_w@a1.eop.gov

At The 9th Annual International

Cost Schedule Performance Management Conference

October 19 - 23, 1997

GPRA

Lineage:

- Construct outlined in President Reagan's last Management Report.
- First drafted in 1991by a Republican Senator during the Bush Administration.
- Became law in August 1993. Passed by a Democratic Congress and signed by President Clinton.
  - >Bipartisan sponsorship
  - >Across the political spectrum
  - >Unanimous vote

Antecedents

- PPBS, MBO, ZBB
- Financial Statements
- Other countries:
  - The Scando-Anglos:

    Australia, New Zealand, United Kingdom, Canada, Sweden
- Sunnyvale
- Oregon
- Private sector
  - analog to the bottom

Coverage

- All Cabinet departments
  - All departmental components
- Nearly every independent agency
- Government-owned or -controlled corporations
- Only the Executive Branch
- Approximately 115 entities
  - 17 were exempted by statute or OMB

The Basic Construct of GPRA

- Strategic Plans
  - >Foundation
- Annual Performance Plans
  - >Execution
- Government-wide Performance Plan
  - >Overall relationship to budget
- Annual Performance Report
  - >Accountability
- Management Flexibility

Schedule

Pilot Phase:

- Performance measurement pilot projects
  - >FY 1994-96
  - >Done
    - – All Cabinet departments
    - – 14 independent agencies
    - – Total of 70+ pilots
- Managerial flexibility pilot projects
  - >FY 1995-96
  - >Annulled

More Schedule

Current Phase:

- Government-wide implementation
  - > Beginning in September 1997.
    - – Strategic Plans
- Government-wide performance plan
  - > February 1998 and annually thereafter.
- Performance budgeting pilots
  - > Yet-to-be
- Program performance reports
  - > A millennium happening

What Are We Trying To Do?

- Ask three questions of any manager

  >What are you trying to achieve?

  >How well are you doing?

  >How do you know?

What Else?

- Focus on program execution
  - >Less emphasis on inputs
    - – People, dollars, process
  - >More emphasis on outputs & outcomes
  - >Less emphasis on policy

- Program entirety rather than deltas

And . . . . .?

- Accountability
- Make GPRA disappear

Strategic Plans

- September 30, 1997
  - >Due to Congress and OMB
- 100 plans due
  - >94 percent delivered
  - >5 percent delayed
  - >1 percent recalcitrant
- Not since the fall of the Soviet Union . . . .
- Marvel of procrastination
  - >50 months post-enactment

What's In A Plan?

- Six required elements
  - >Mission statement
  - >General goals and objectives
  - >Means and strategies
  - >Relationship between general goals and annual performance goals
  - >External factors
  - >Program evaluation

More On Strategic Plans

- Cover at least a six-year period.
- Revised and updated every three years.
  - >By September 2000
  - >Minor adjustments can be made annually.
- Consultation with Congress
- Outreach and opportunity for interested or potentially affected parties, e.g.., stakeholders, customers, to provide views

Getting To September 30th

- OMB Guidance
  - >Issued September 1995
  - >Interagency task group (Jan. 1995)
- OMB Reviews of Draft Plans
  - >Summer 1996, Spring 1997.
- GAO
  - >Checklist
  - >Letter reports
- Congress
  - >House teams
  - >Scorecard

More on Getting There

- Interagency clearance
  - >OMB checklist
  - >Consistency among goals for cross-cutting programs
  - >Consistency with President's program
    - – A strategic plan is not a budget request!
- Transmittal letter
  - >Summary of consultation
  - >Contrary views
  - >Use of contractors/consultants

What’s the Result?

- No perfect plans
  - >No model plans, either.
- Substantial improvement from earlier drafts.
  - >Higher scores
- 94 agency plans that were sent on time, and the met the basic requirements of the statute.
- A likelihood that many agencies will make minor adjustments to these plans next February.
- Continuing selected consultation.

Using Strategic Plans

- Foundation for annual performance plan
  - >Progress in accomplishing long-term goals.
  - >Incremental and derivative.

Annual Performance Plan

- Three basic elements:
  - >Annual performance goals and indicators
  - >Means and strategies
  - >Description of how data will be verified and validated.
- Distinctions:
  - >All program activities vs. major functions
  - >Tied to specific budget accounts rather that agency aggregate level.

Sequence of the Annual Performance Plan

- September:

  to OMB with the budget request

- February:

  to Congress, concurrent with the President's budget.

  >revised to reflect budget decisions.

- September/October:

  'operating plan' at agency choice.

  >revised to reflect appropriations.

Nuances

- Alternative form of measurement
  - >non-qualified goal
  - >authorized by OMB
  - >descriptive statements of satisfactory and minimally effective program
- Aggregation, dis-aggregation, consolidation of program activities
- Budget year funding of future year performance
- Budget year performance funded by past years

More Nuances

- Use of regulation and tax expenditures
- Managerial Flexibility Waiver Requests
- Management problems
- Capital planning

Several Examples of Goals

- Improve productivity by 10 percent.
- Promote economic growth in Appalachia.
- Maintain combat forces at a high level of readiness.
- Reduce product defects.
- Eliminate errors.

Web Sources

Fedworld: www.fedworld.gov/pub/results/results.htm

NPR: www.npr.gov/initiati/mfr/

Congressional Institute: server.conginst.org/conginst/results/

Financenet: www.financenet.gov/financenet/fed/cfo/gpra/

GAO: www.gao.gov/special.pubs/gpra.htm

Government Executive:
www.govexec.com/dailyfed/0997/090897b1.htm

Mr. Armey: armey.house.gov/results/welcome.htm

Cost As An Independent Variable (CAIV) Acquisition Strategies: A Brief Overview

9th International Cost/Schedule Performance Conference
Tysons Corner, Virginia
October 22, 1997

Presented by:

Nicholas A. Koreisha
202/739-8711

Valerie LaPlaca-Mars
202/467-3397

Overview

- What is CAIV?
- CAIV's History and Evolution
- Use of Earned Value Management in CAIV Acquisition
- CAIV's Impact on Acquisition Management
  - Current Trends
  - Future Trends
- Where To Learn More

What is CAIV?

CAIV is DoD's acquisition methodology of making technical and schedule performance a function of available (budgeted) resources.

Strategy

- Aggressively set realistic cost objectives for acquiring and supporting defense systems, and
- Manage programs to meet those objectives.

Approach

- Set realistic but aggressive cost objectives early in each program
- Mange risks to achieve cost, schedule and performance objecives
- Devise metrics for tracking progress in setting and acheiving cost objectives
- Motivate/incentivize goverment/industry to acheive objectives
- Incentivize operating and support cost reductions for fielded systems

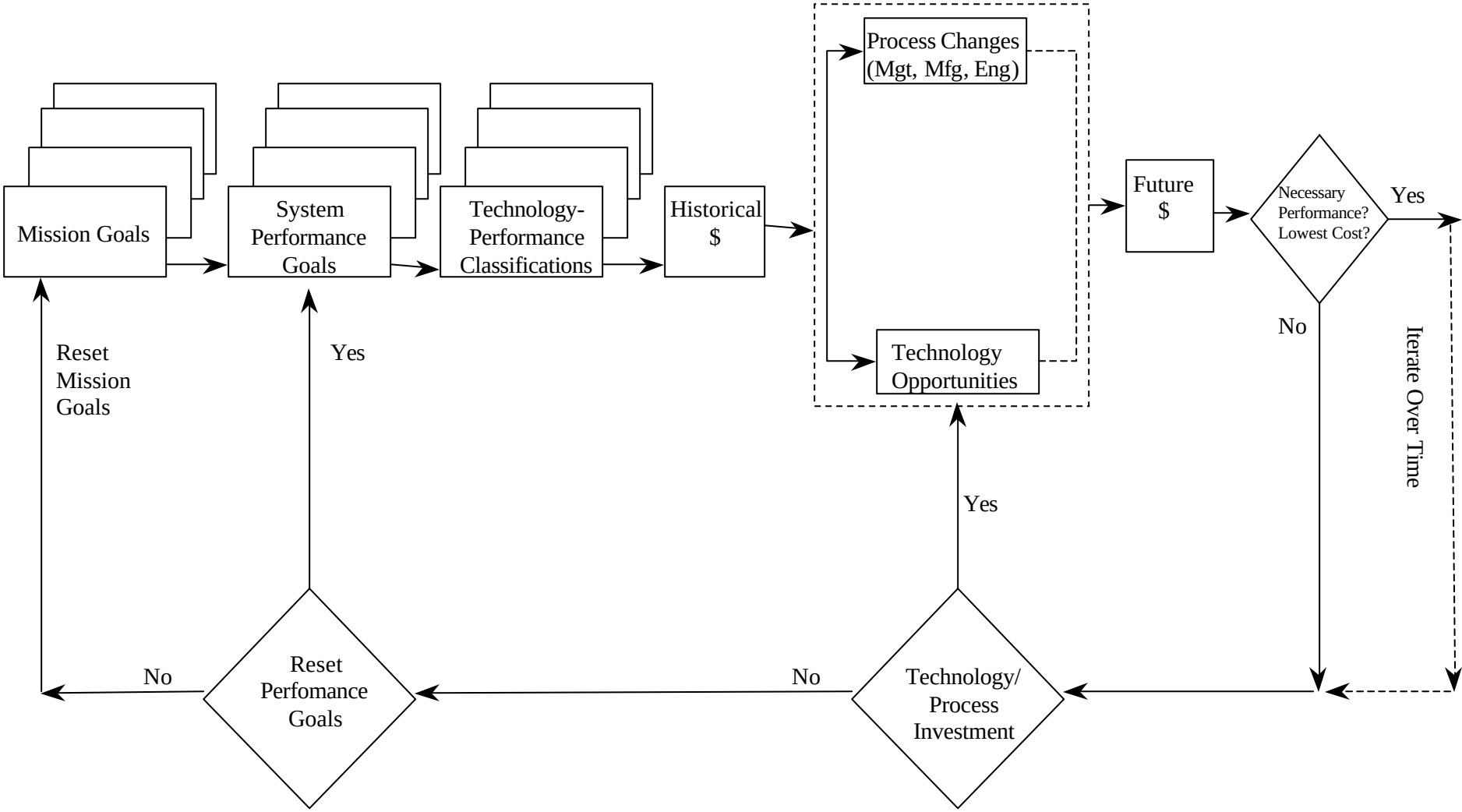
CAIV is...

Explained another way...

- Three program performance parameters
  - Technical
    - Schedule
      - Cost (Price)
  - Two of these variables must depend on the third

- Systematic analysis of all life cycle cost elements
  - Acquisition
  - Operations/Support
  - Manpower
  - Modernization
  - Disposal

Cost/Performance Optimization Process



CAIV's History and Evolution

- Based on commercial practice
- History is in the making, now!
  - 1995 - 1996
    - OSD policy on cost/performance trade-offs
    - Test implementation on flagship Army/Navy/Air Force/Marine Corp programs
  - 1997 - 1998
    - Services' promulgate policy/guidance documents, business plans
- Why CAIV? Improves systems acquisition cost estimating diligence and program controls.

Use of Earned Value Management in CAIV Acquisition

- CAIV's "first diagnostic of risk management".
- Principle method of validating whether expected cost performance will be met
- Tool for adjusting performance requirements to meet cost objectives
- Performance monitoring (expected life cycle cost validation) conducted on an ongoing basis through all Acquisition phases:
  - Concept Exploration
  - Program Definition and Risk Reduction
  - EMD/LRIP
  - Production, Fielding/Deployment, Operational Support

CAIV's Impact on Acquisition Management: Current Trends

- Increasing rigor in cost modeling
- Cost/Performance Integrated Process Teams (CPIPT)
- Existing data quality/granularity - limiting the quality/sophistication of post-acquisition life cycle costing
- New contract incentives
- Program reporting: improved quality

CAIV's Impact on Acquisition Management: Future Trends

- Improved systems engineering - performance tradeoff and cost/performance tradeoff tools
- Renewed interest in VECPs as incentives
- Continued risk management method improvements
- Increased use, improvements to technical performance management (TPM)
- Improvements to historical O&S cost databases
- Increased focus on data quality during the cost data collection process
- Increased focus on industry/contractor process cost data associated with Government systems - ABC/ABM

Where to Learn More

- Web Sites
  - http://www.acq.osd.mil/ar/
  - http://www.acq-ref.navy.mil/wcp/civ.html
  - http://www.safaq.hq.af.mil/safaq/acq_pol/caiv.html
  - http://navsea.navy.mil/acquisition-reform/caiv.htm
  - http://www.pricesystems.com/caivsemi.htm

- Future military service guidance documents

TECHNICAL
PERFORMANCE
MEASUREMENT
ASSOCIATES, INC.

Technical Performance Measurement

- The Basics and *Beyond* -

Kathryn Kulick

9th Annual Cost Schedule Performance Management Conference

October 22, 1997

TECHNICAL
PERFORMANCE
MEASUREMENT
ASSOCIATES, INC.

BCWP

INTEGRITY

Systematic TPM

Purpose

To ensure that the proper foundation is in place from which to produce the most accurate EV assessment possible for technical development activities

---

Exceedingly relevant, and an important contributor, to EV

Scope

Broad, very detailed and commonly considered to be an "engineering" responsibility.

Actually crosses over many disciplines and their knowledge bases, including:

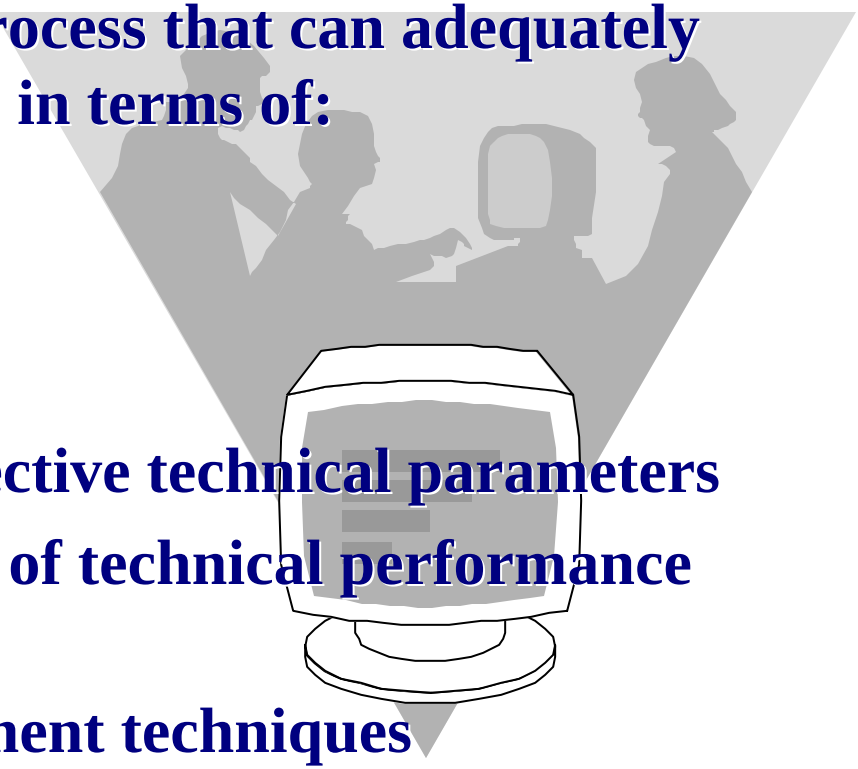
- **decision theory,**
- **information management,**
- **cost analysis,**
- **scheduling,**
- **risk analysis,**

……as well as engineering

Systematic TPM

What the Manager Needs to Know

- How to identify a TPM process that can adequately support EV management, in terms of:
  - monitoring
  - assessment
  - integrated analysis
- The characteristics of effective technical parameters
- The primary components of technical performance baseline plans
- Pro's and con's of assessment techniques



Effective TPM

- **Procedurally consistent and, therefore, systematic**
- **Continuously documented, from planning through monitoring and assessment**
- **Provides for direct linkage of technical metrics to associated budgets, whether via WBS, IPT codes, or other structures**
- **Enjoys the support and commitment of key management personnel and a central point of contact, but is procedurally implemented throughout the program**
  - everyone with technical development responsibilities contributes to it

Effective TPM

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- Provides for direct linkage of technical metrics to associated budgets, whether via WBS, IPT codes, or other structures
- Enjoys the support and commitment of key management personnel and a central po implemented throughout t
  - everyone with technical contributes to it

Not a "streamlining" activity

Not a process improvement

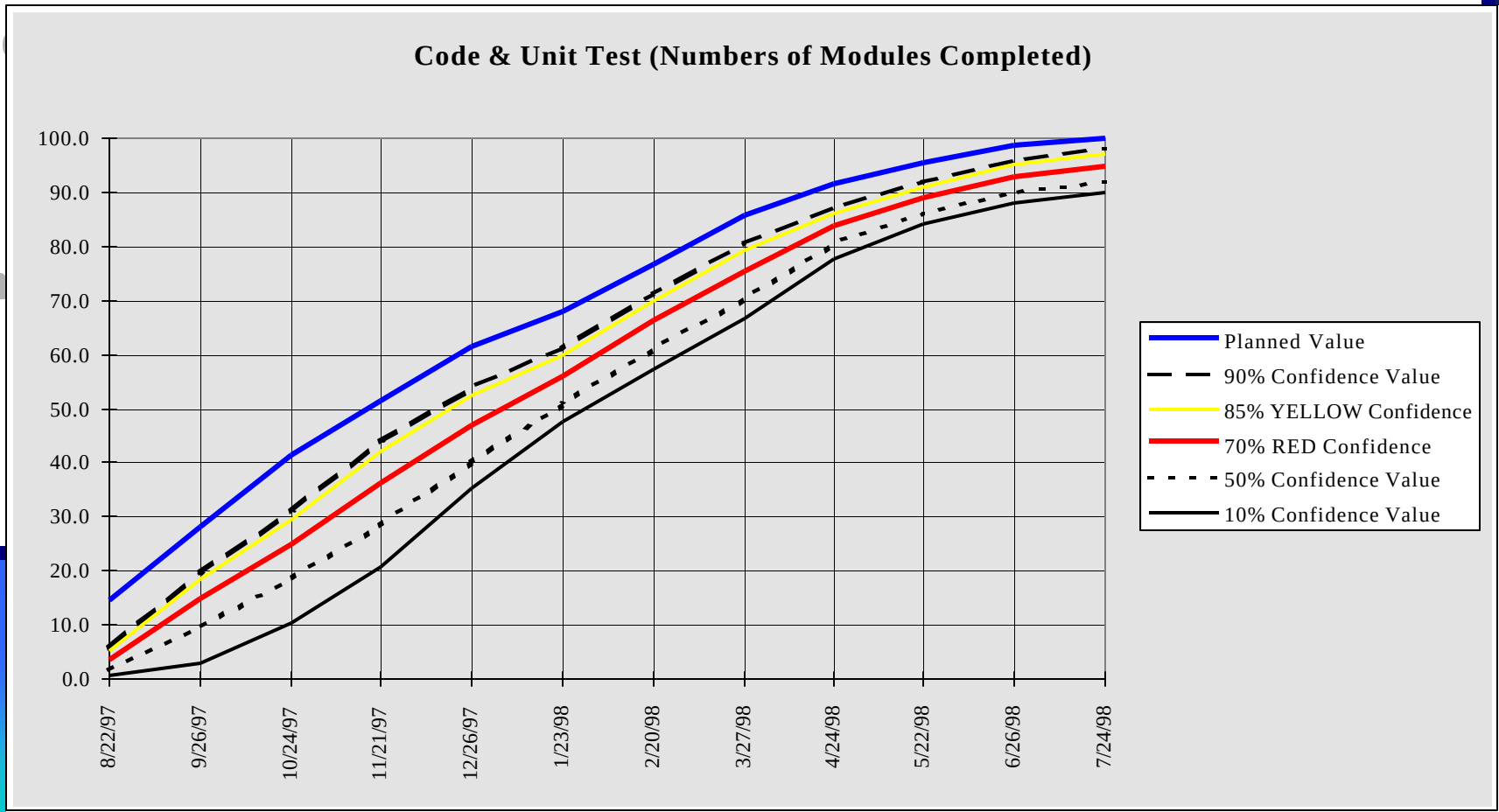
A *new* process

Effective TPM

- **Aggregates results of technical measures which clearly indicate the level of technical success achieved toward the Program mission, or MENS, at any given point in time**
  - requires a comprehensive set of ***key*** metrics
  - can't just do a "little piece" of the program
- **Employs strict baseline planning**
  - not just for measurement expectations and goals, but also for assessment tolerances

Effective TPM

- Aggregates results of technical measures which clearly indicate the level of technical success achieved toward the Pr
  - —
  - —
- En
  - —



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  - requires a comprehensive set of ***key*** metrics
  - can't just do a "little piece" of the program
- **Employs strict baseline planning**
  - not just for measurement assessment tolerances

Not a replacement for human reasoning

An attempt to assist and improve it

Technical Parameters

- General characteristics:
  - Measurable
  - As a group, parameters are measurable throughout the development schedule, but particularly during the early phases of the program
  - Can be directly associated with likely risk areas, or requirements key to success of the program
- Parameter types:
  - Performance
    - Examples: speed, weight (empty and gross), cooling/ambient temp., mission radius, range, velocity, aeroelastic stability, radar cross section, receiver sensitivity, noise, accuracy
    - Highly measurable, but not early in a program unless significant modeling activities are undertaken
    - Easily associated with key program requirements

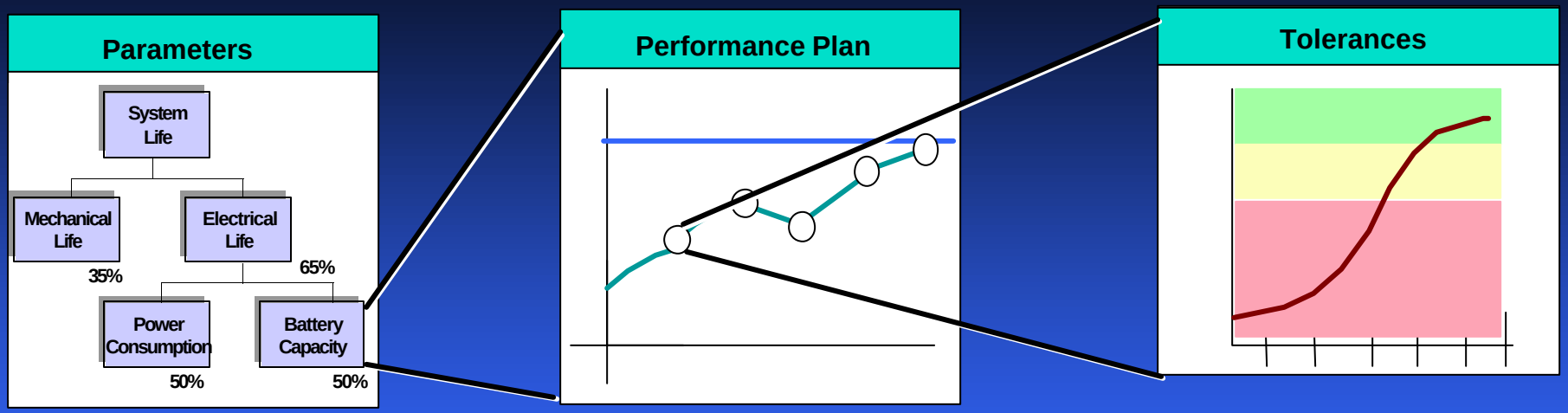
Technical Parameters

- Supportability (includes reliability and maintainability):
  - Examples: MTBF, MTTR, MTBCF, % of standard components, level of modularity, upgrade/expansion capability, support equipment availability, avionics fault detection, mechanical deployment reliability
  - Frequently related to common risk areas
- Software
  - Examples: S/W requirements stability, design and code (modules completed), unit test (modules passed), FQT (modules passed), S/W size estimated (SLOC, a measure of efficiency), S/W size delivered (SLOC), memory utilization/reserve (% of capacity), processor throughput
  - Comprise a major risk area on most programs
  - Many are measurable during the early phases of development

Technical Parameters

- Producibility
  - Examples: critical material avail., special manufacturing equip. avail., special facility avail.
  - If these can be modeled during development, can be very effective indicators of overall program success
- Engineering processes
  - Examples: rework/redesign (% of labor hours), yield (first time production inspection success rate), staffing, design progress (including document prep.), problem reports closed, safety hazards mitigated
  - early indicators of productivity and product quality
- Affordability
  - Examples: design-to-cost (unit recurring), life cycle cost
  - Can be modeled throughout the development
  - Represents an ever-increasing concern to design systems to cost

Establishing the Technical Performance Baseline



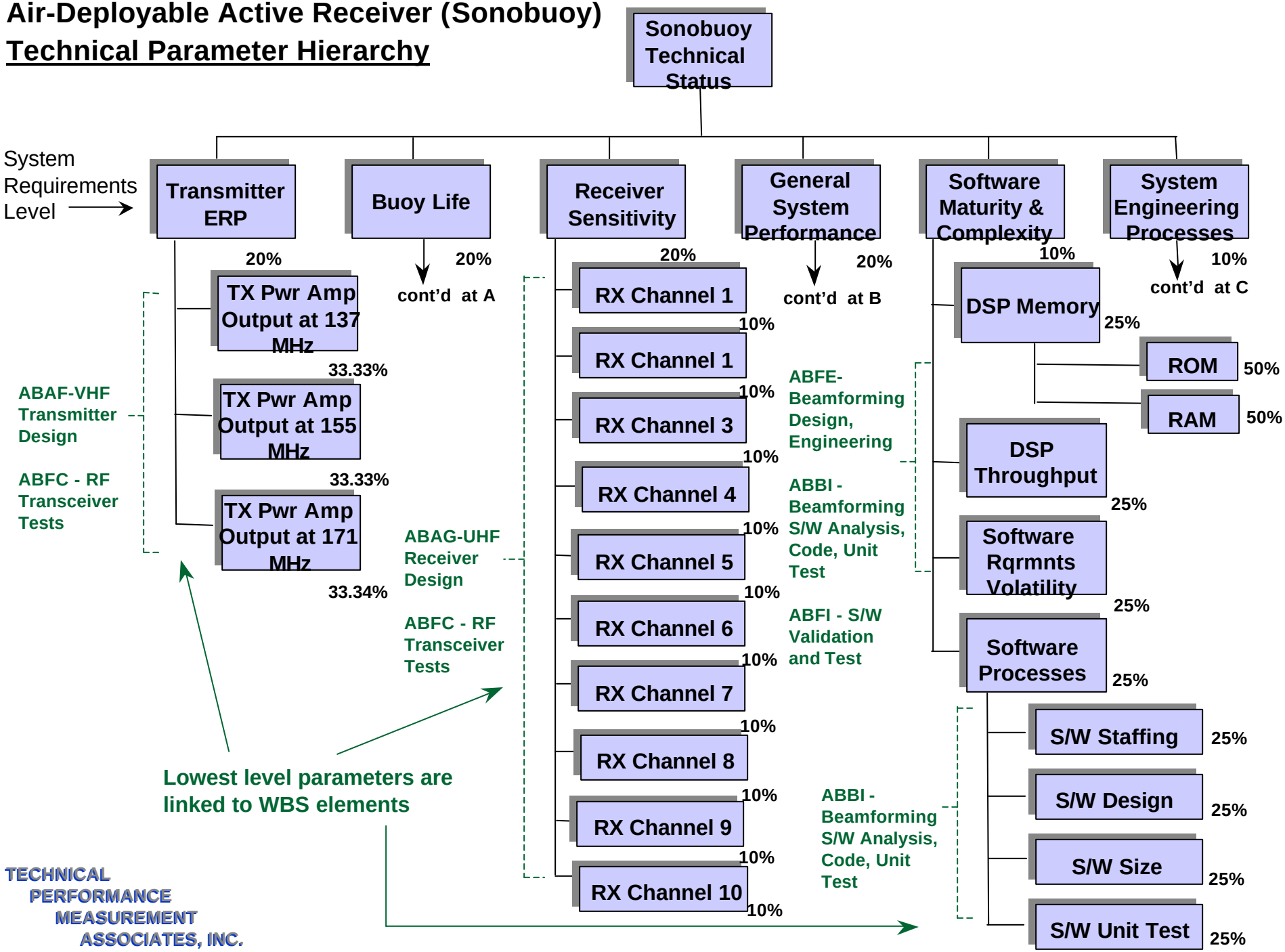
Hierarchy structure establishes relationships and relative importance of parameters

Facilitates aggregation of technical status

Time-phased plan of expected measurement values and the performance objective for each parameter

Time-slice representation of tolerances for each measurement date on a given performance plan

Air-Deployable Active Receiver (Sonobuoy)
Technical Parameter Hierarchy



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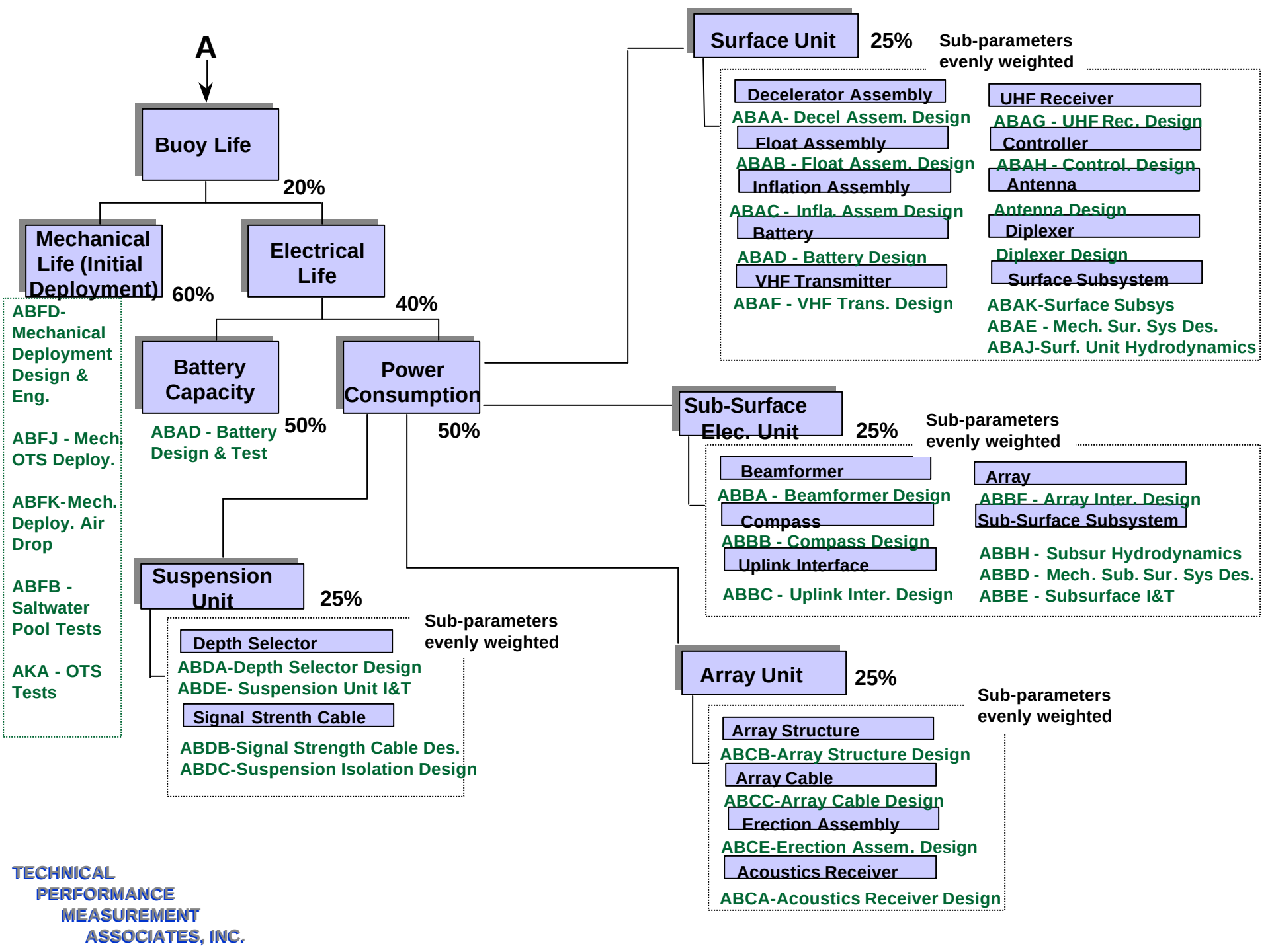

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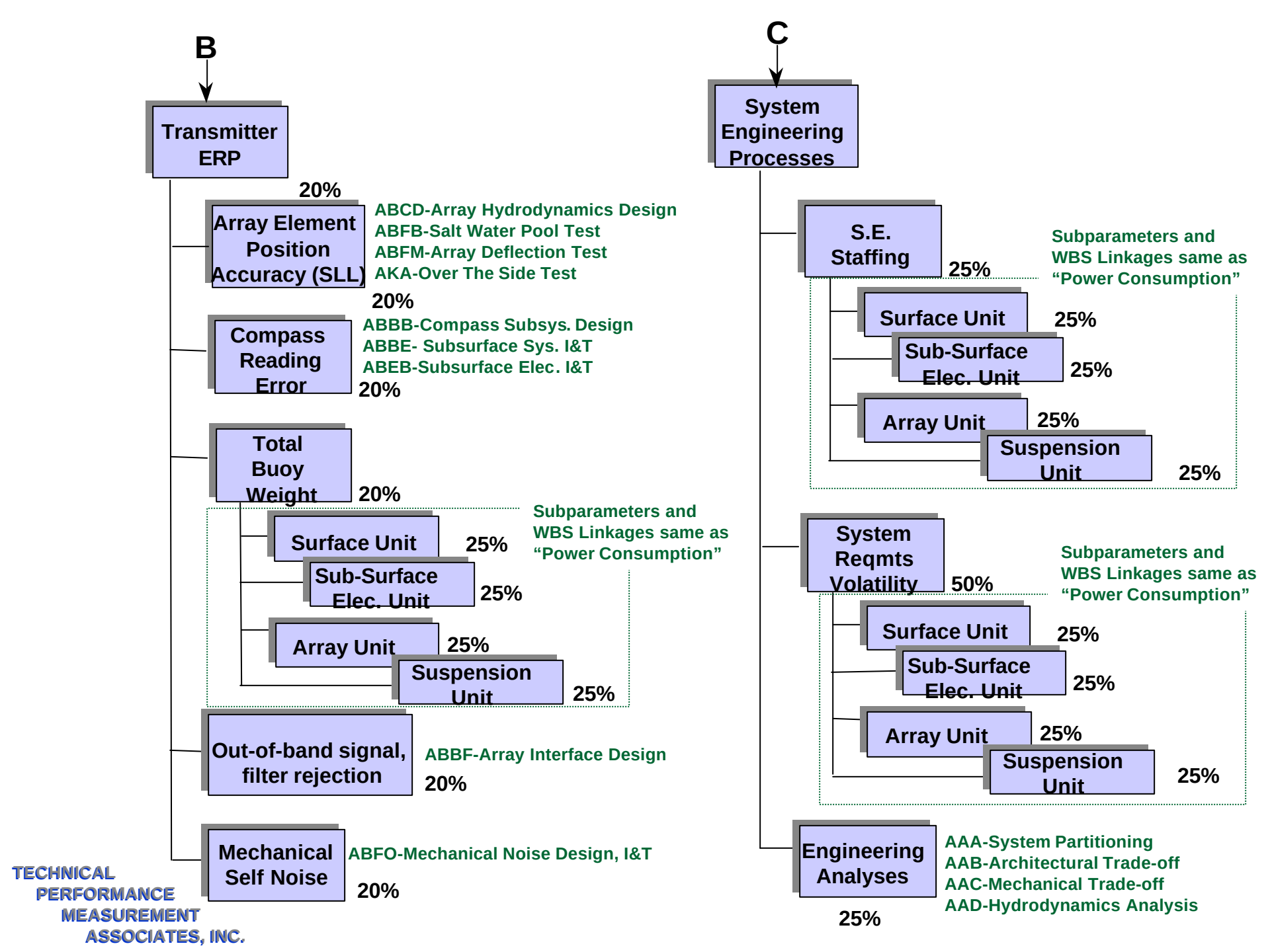
B
Transmitter ERP
20%
Array Element Position Accuracy (SLL)
ABCD-Array Hydrodynamics Design
ABFB-Salt Water Pool Test
ABFM-Array Deflection Test
AKA-Over The Side Test
20%
Compass Reading Error
ABBB-Compass Subsys. Design
ABBE- Subsurface Sys. I&T
ABEB-Subsurface Elec. I&T
20%
Total Buoy Weight
20%
Subparameters and WBS Linkages same as "Power Consumption"
Surface Unit
25%
Sub-Surface Elec. Unit
25%
Array Unit
25%
Suspension Unit
25%
Out-of-band signal, filter rejection
ABBF-Array Interface Design
20%
Mechanical Self Noise
ABFO-Mechanical Noise Design, I&T
20%
C
System Engineering Processes
S.E. Staffing
25%
Subparameters and WBS Linkages same as "Power Consumption"
Surface Unit
25%
Sub-Surface Elec. Unit
25%
Array Unit
25%
Suspension Unit
25%
System Reqmts Volatility
50%
Subparameters and WBS Linkages same as "Power Consumption"
Surface Unit
25%
Sub-Surface Elec. Unit
25%
Array Unit
25%
Suspension Unit
25%
Engineering Analyses
25%
AAA-System Partitioning
AAB-Architectural Trade-off
AAC-Mechanical Trade-off
AAD-Hydrodynamics Analysis
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Technical Parameter Aggregation by WBS

- Facilitates Calculation of Technical Status for Applicable WBS Elements -

ABAD - Battery Design & Test

- Battery Capacity
- Surface Unit Battery Power Consumption
- SE Staffing (Surface Unit)
- System Requirements Volatility

ABAF - VHF Transmitter Design

- Tx Pwr Amp Output at 137 MHz
- Tx Pwr Amp Output at 155 MHz
- Tx Pwr Amp Output at 171 MHz
- Surface Unit VHF Transmitter Power Consumption
- SE Staffing (Surface Unit)
- System Requirements Volatility

ABBB - Compass Subsystem Design

- Compass Reading Error
- Sub-surface Elec. Unit Battery Power Consumption
- SE Staffing (Sub-surface Elec. Unit)
- System Requirements Volatility

ABFC - RF Transceiver Tests

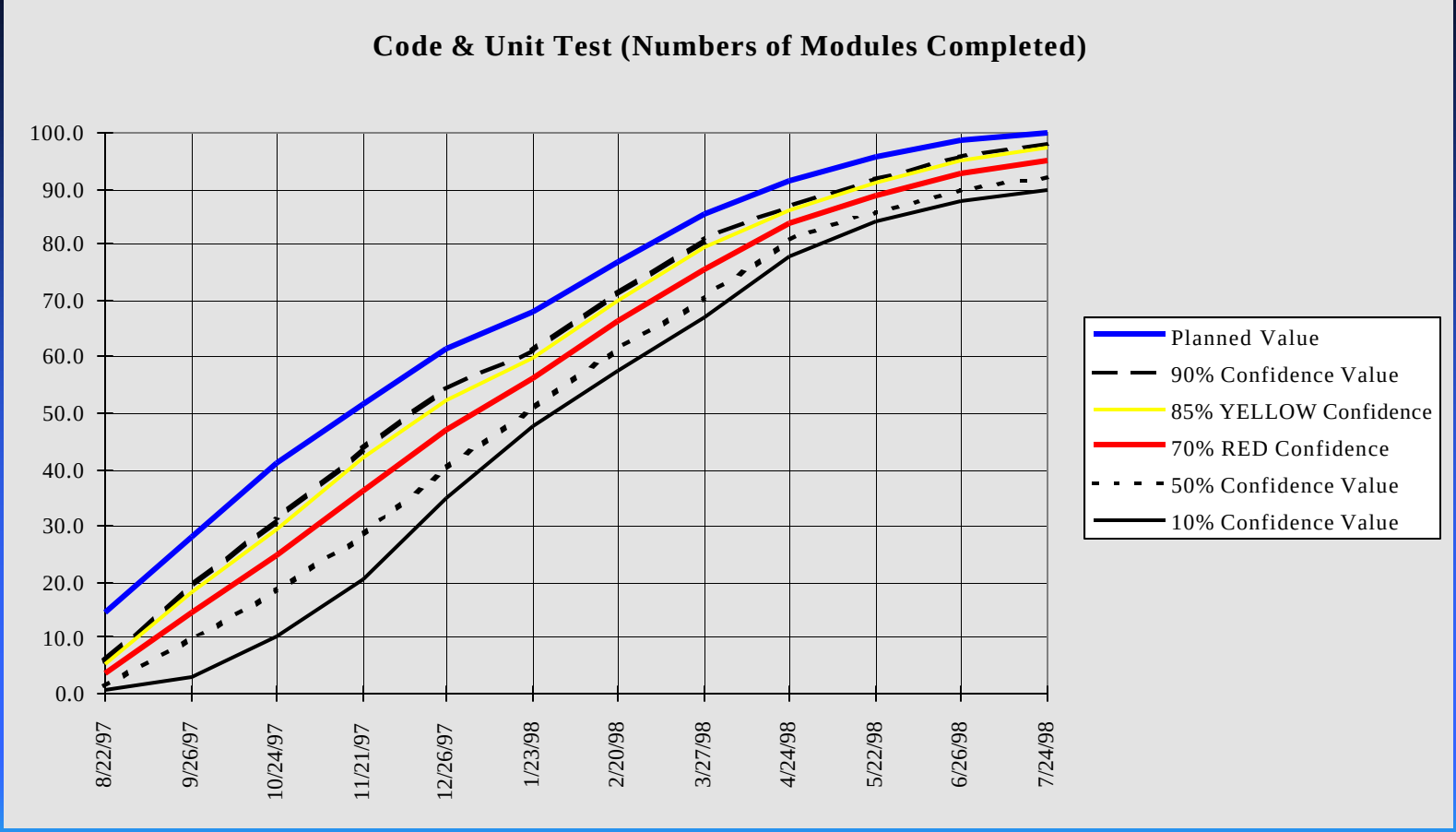
- Tx Pwr Amp Output at 137 MHz
- Tx Pwr Amp Output at 155 MHz
- Tx Pwr Amp Output at 171 MHz
- Rx Channel 1 Sensitivity
- Rx Channel 2 Sensitivity
- Rx Channel 3 Sensitivity
- Rx Channel 4 Sensitivity
- Rx Channel 5 Sensitivity
- Rx Channel 6 Sensitivity
- Rx Channel 7 Sensitivity
- Rx Channel 8 Sensitivity
- Rx Channel 9 Sensitivity
- Rx Channel 10 Sensitivity

AKA - Over-The-Side Tests

- Array Element Position Accuracy
- Mechanical Life

First step toward integration with C/S

Performance Plans and Tolerances



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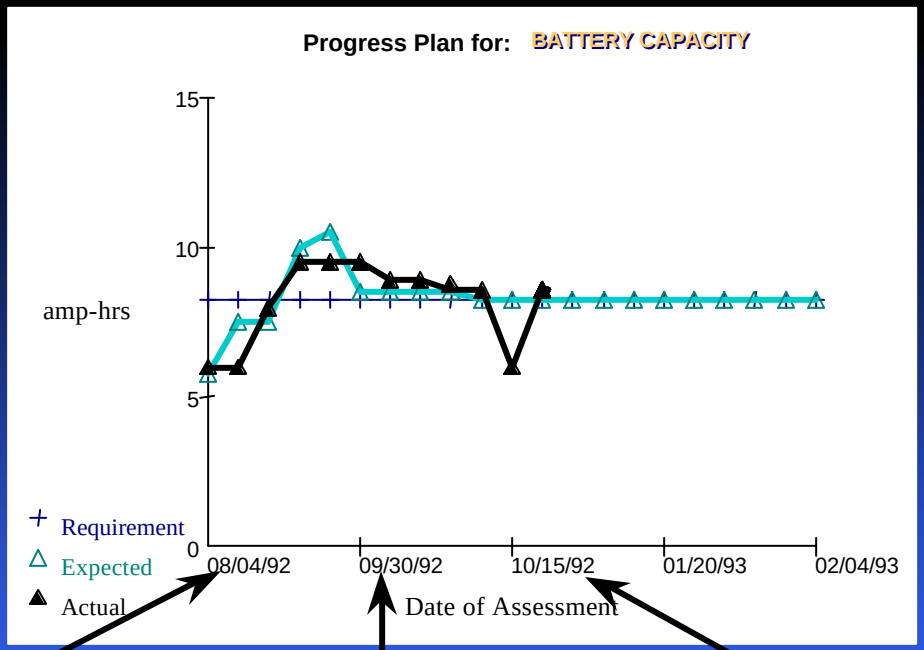
Performance Plans and Tolerances - Data Collection

Name	Jane Doe			Date	9/3/97	Next Interview	Page 1 of 1
Phone	703-555-1212	Bldg 72	Room 220	Interviewer		Tech. Achievement Plan?	ID
TPM Parameter Description	Code and Unit Test (Numbers of Modules Completed)			CWBS	1224	Suitable for Simulation?	Results?
				Risk Item?		Notes	
				Status Code			
Type of Risk Curve:	Single X	Double	Other Custom	Distribution Type			
DATA POINTS	Continuous X	Discrete	Step Function?				

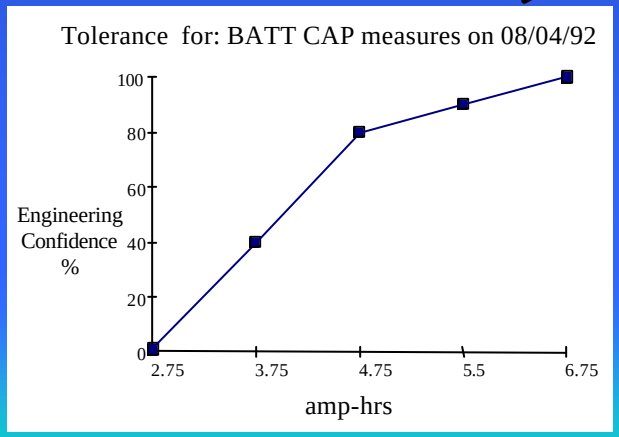
Parameter Measurement Milestones (MS)		Lower Bounds (Tolerance Band) Likelihood of Achieving PV* at next milestone						Profile Credit	Upper Bounds (Tolerance Band) Likelihood of Achieving PV* at next milestone						Line		
		10%		50%		90%		100%	90%		50%		10%		Nbr		
MS ID	Date	10% Confidence Value	% of PV	50% Confidence Value	% of PV	90% Confidence Value	% of PV	Planned Value	Value	% of PV	Value	% of PV	Value	% of PV		70% RED Confidence	85% YELLOW Confidence
CDR	8/22/97	0.7	5%	1.5	10%	5.8	40%	14.6							1	3.7	5.3
	9/26/97	2.8	10%	9.8	35%	19.6	70%	28.0							2	14.7	18.4
	10/24/97	10.3	25%	18.5	45%	30.9	75%	41.2							3	24.7	29.4
	11/21/97	20.7	40%	28.4	55%	43.9	85%	51.7							4	36.2	42.0
	12/26/97	35.1	57%	40.0	65%	54.2	88%	61.6							5	47.1	52.4
	1/23/98	47.6	70%	51.0	75%	61.2	90%	68.0							6	56.1	59.9
	2/20/98	57.5	75%	61.4	80%	71.3	93%	76.7							7	66.3	70.1
	3/27/98	66.8	78%	70.3	82%	80.6	94%	85.7							8	75.4	79.3
	4/24/98	77.9	85%	80.6	88%	87.0	95%	91.6							9	83.8	86.2
	5/22/98	84.1	88%	86.0	90%	91.8	96%	95.6							10	88.9	91.1
	6/26/98	87.9	89%	89.9	91%	95.8	97%	98.8							11	92.9	95.1
Int Test	7/24/98	90.0	90%	92.0	92%	98.0	98%	100							12	95.0	97.3

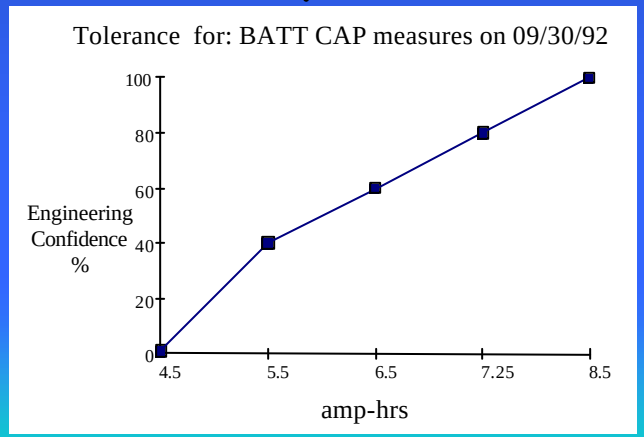
Performance Plans and Tolerances

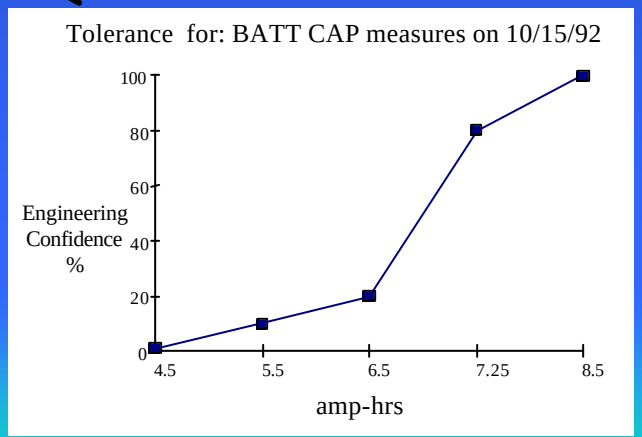
- Employs engineering confidence assessment for technical performance planning to quantify each measurement in terms of the probability success of achieving the next expected measurement goal
- Places all parameters on a common unit of measure for summary roll-ups of technical status



- Isolates subjectivity at up-front planning stage, allowing measurement activities/milestones to become objective assessments

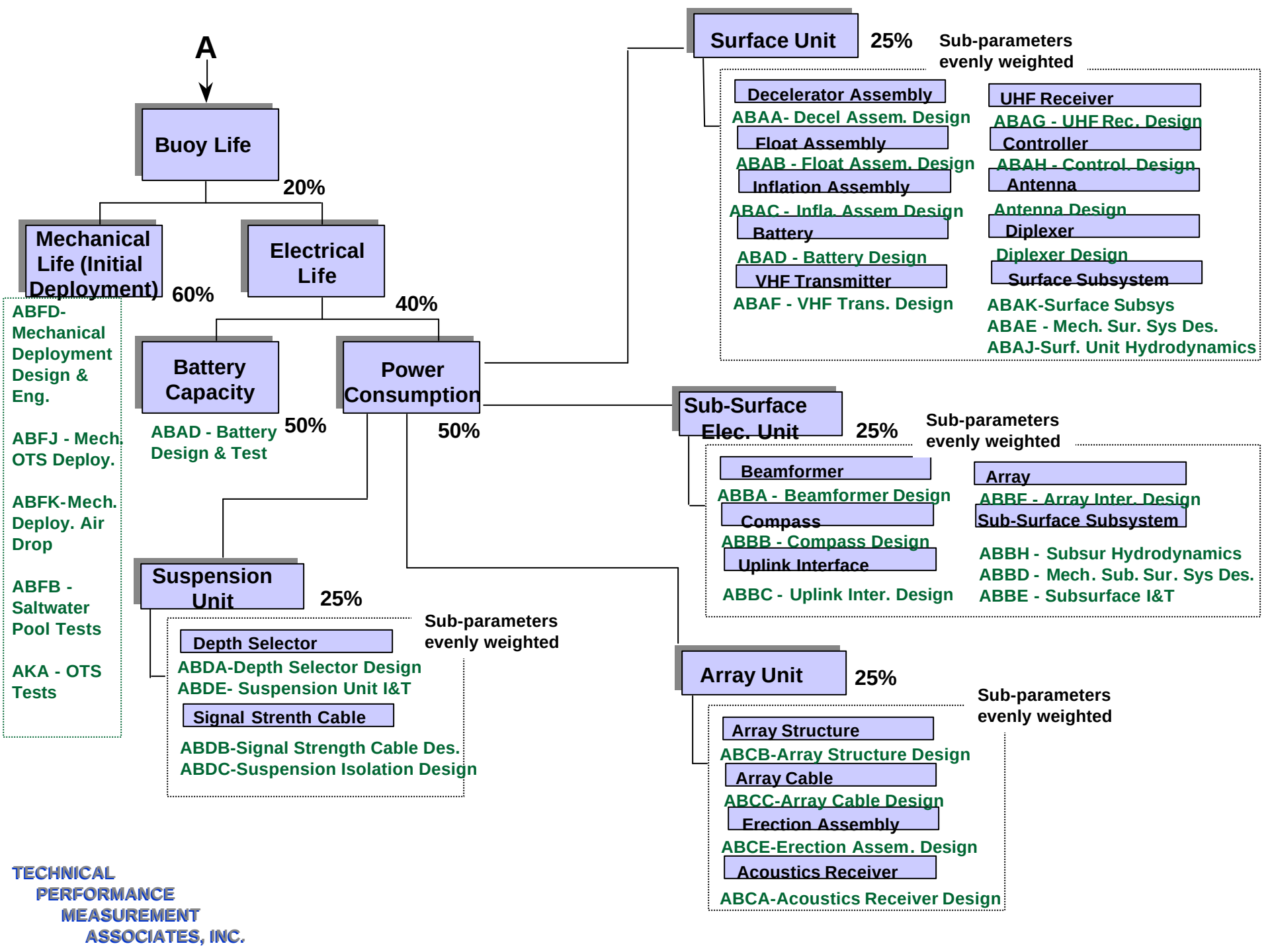






Assessment Techniques & the *Beyond*

- Manual development of tolerances such as risk profiles is limited in its ability to fully establish the relationships between the parameters themselves
- Operating in environments rife with uncertainties, the manual approach leaves holes in the probabilistic assessments of technical status
- Parameter relationships are incomplete, defining only “relative importance” resulting in an impure probabilistic approach
- The use of artificial intelligence techniques such as Belief Networks can fill in these gaps by capturing believed relations between the parameters as part of the baseline process



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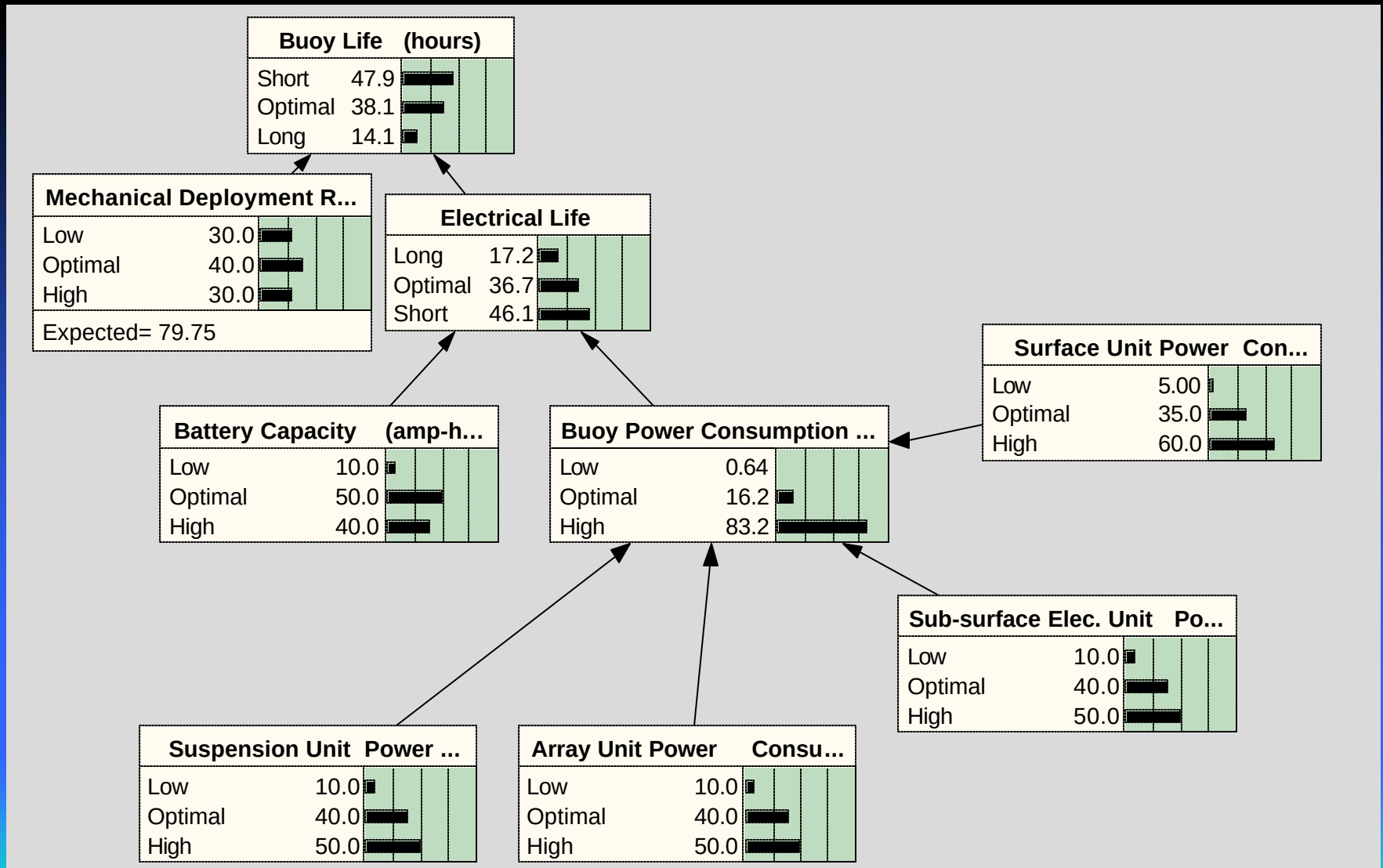
Belief Network Representation



Relationship Table

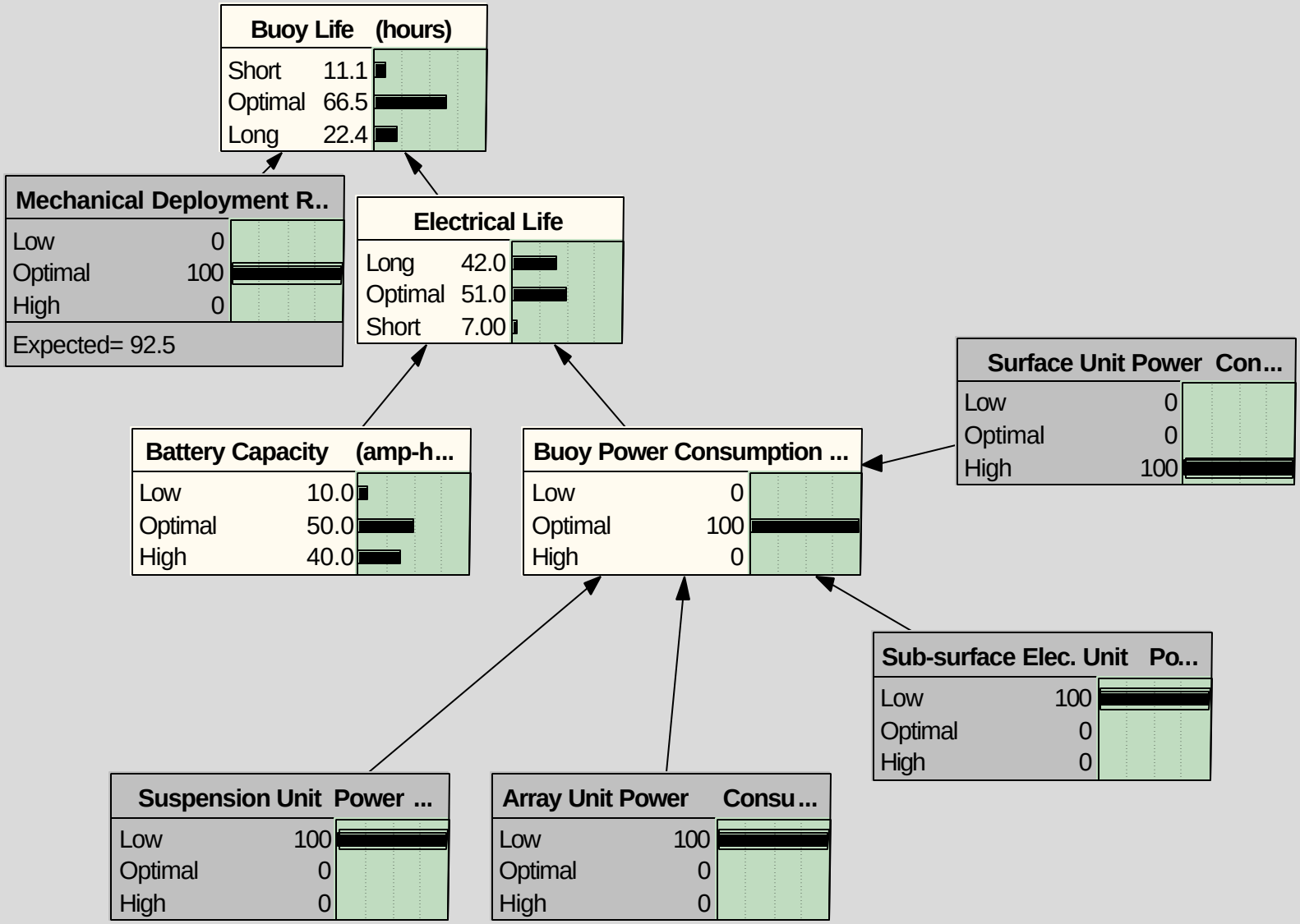
Node: electrical_life

Chance

Apply | Okay | Load | Close

buoy_pwr...	battery_ca...	Long	Optimal	Short
Low	Low	10.000	50.000	40.000
Low	Optimal	60.000	40.000	0.000
Low	High	100.00	0.000	0.000
Optimal	Low	0.000	30.000	70.000
Optimal	Optimal	20.000	80.000	0.000
Optimal	High	80.000	20.000	0.000
High	Low	0.000	0.000	100.00
High	Optimal	0.000	20.000	80.000
High	High	30.000	60.000	10.000

Belief Network Updated with Findings



Summary of Effective TPM

- **Procedurally consistent and continuously documented**
- **Direct linkage of technical metrics to associated budgets**
- **Has the support and commitment of key management personnel and a focused staff**
- **Aggregates results of technical measures**
  - requires a comprehensive set of ***key*** metrics
- **Employs strict baseline planning**
- **Key parameters are measurable throughout the development schedule, but particularly during the early phases of the program**
  - should be aggregated by WBS for integration with C/S
- **Parameter relationships must be detailed to the fullest extent possible to obtain sound probabilistic assessments relating to forecasts of technical success**
  - use of AI techniques to aid human reasoning

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